Water Plant Optimization Study

NIAGARA FALLS WATER TREATMENT PLANT

December 1990

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Water Plant Optimization Study

Niagara Falls
Water Treatment Plant

Project No. 7-2005

December 1990

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WATER PLANT OPTIMIZATION STUDY
NIAGARA FALLS WATER TREATMENT PLANT

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The purpose of the Water Plant Optimization Study (WPOS) is to document and review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on the removal of particulate materials and the disinfection processes.

In striving for excellence in water treatment, it is important to examine all possible approaches, but first, optimum use should be made of the processes already in place.

This optimization study is a beginning and not an end to itself; it is the start of an ongoing documentation of the operation of the plant. It is recommended that this document be updated on an annual basis.

This plant location was chosen for the MOE study of Trace Organics Removal, which was proceeding during the period of this study.

The plant is presently installing a computerized operating system which includes a process control system for the plant and distribution system, and on-line status reporting. This system should improve the data collection and process control of the plant.

The Niagara Falls Water Treatment Plant is characteristic of those found in Regional Niagara in that operational staff are continuously interested and involved in optimization of the process, and are supported in these endeavours by Regional management. In this regard, the Niagara Falls plant has made considerable strides towards optimization; however, in an examination of this depth, areas of further action and study have been identified and are listed on the following page.

SUMMARY OF FINDINGS AND RECOMMENDATIONS (cont'd)

PHYSICAL IMPROVEMENTS

- Provide a method of recording the separate flows for plant Sections 1 and 2.
- Install alum pump calibration equipment.
- Consider a streaming current monitor system with separate monitors for Sections 1 and 2 if its merits are proven by further tests.
- Provide separate coagulant application points for plant Sections 1 and 2.
- Convert plant Section 1 flocculation tanks to bottom entry.
- Provide a chlorine scale to allow separate measurement of pre and post dosages.

STUDIES

- Conduct laboratory and plant scale testing to evaluate the merits of flash mixing.
- Consolidate and continue to study the use of coagulant aids.
- Conduct plant scale studies on the effects of flow rate on the flocculation tank performance.
- Evaluate the sedimentation tank short circuiting.
- Conduct plant scale testing to evaluate the effect of lower filtration rates on filter effluent quality.
- Evaluate the optimum backwash water volumes.

OTHER RECOMMENDATIONS

- Record the backwash water volumes
- The Ministry of the Environment should develop a surrogate measurement for chlorinated by-products for use in water plants in Ontario
- Transfer to other jurisdictions the technology and management strategies developed and used in the Niagara Region, especially in the areas of:
    - record keeping
    - filter operation
    - filter media characterization
    - plant maintenance

WATER PLANT OPTIMIZATION STUDY
NIAGARA FALLS WATER TREATMENT PLANT

TERMS OF REFERENCE

The terms of reference for this report are included at the back of the report, following the appendices.

The terms of reference for the overall program have evolved during the period of this study. So as to make this report similar to later reports, we have included items which are requested in the newer terms of reference.

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TERMS OF REFERENCE

SECTION A

RAW WATER SOURCE

SECTION A
RAW WATER SOURCE

A.1 General Quality

The Niagara Falls WTP takes raw water from Lake Erie via the Niagara River and the Welland River Channel. The majority of the time, the raw water comes from the Niagara River, since the Welland River flow is diverted by Ontario Hydro. It is possible for the plant to receive Welland River water.

The configuration of the Niagara River upstream of the confluence of the Welland River has the Chippawa Channel on the Canadian side and the Tonawanda Channel on the American side. Much of the potential contaminants tend to pass through the Tonawanda Channel as shore-attached plumes. The Chippawa Channel can receive some contaminants from the Buffalo Harbour area, but this will be quite variable due to wind and wave action.

In the years 1983 to 1986, the general raw water quality parameters varied as follows:

Turbidity (FTU)	0.45-51
Colour (TCU)	2.5-9.5
Temperature (°C)	1-25
Alkalinity (mg/L as $CaCO_3$)	95-105
Hardness (mg/L as $CaCO_3$)	117-132
pH	7.1-8.4
Aluminum (mg/L)	0.009-0.380
Threshold Odour Numbers	0-2

Taste and odour is a seasonal problem, and typically occurs in July and August, but has been minimal in recent years.

SECTION B

FLOW MEASUREMENT

SECTION B
FLOW MEASUREMENT

B.1 Raw

The original plant was built in 1930 and is referred to as Section 1. The newer part of the plant was built in 1954 and is referred to as Section 2. Raw water is measured separately for Section 1 and Section 2 of the plant.

The meters are:

Section 1 - 600 mm, Universal venturi insert, 0 to 75 ML/d capacity
Section 2 - 600 mm, Universal venturi insert, 0 to 75 ML/d capacity

The total raw water flow is recorded on a 305 mm diameter chart and totalized continuously in the control room. The totalized flow is recorded every eight hours on the daily record and totalled for the day.

B.2 Treated

There are two discharge treated water mains leaving the Niagara Falls WTP, and each has its own meter and transmitter.

The meters are:

750 mm, Universal venturi insert, 0 to 70 ML/d capacity
900 mm, Universal venturi insert, 0 to 150 ML/d capacity

The total treated water flow leaving the plant is recorded on a 305 mm diameter chart and totalized continuously in the control room. The total treated flow is recorded every eight hours on the daily record and totalled for the day.

B.3 Backwash

There are two backwash pumps discharging into a common header, which is metered. Backwashing is normally accomplished by using one of the pumps. There is also

B.3 Backwash (cont'd)

an elevated backwash holding tank that can be used if the backwash pumps are out of service. The backwash tank is isolated from the washwater header with an isolation valve, which is normally closed. The flows from the tank are not metered.

B.4 Filters

The original eight filters, numbered 1A, 1B, 2A, 2B, 3A, 3B, 4A, and 4B, are now considered as four filters, since the flow from each pair is metered together; e.g. the flow from 1A and 1B goes through a common meter. Therefore, there are four meters that serve the original eight filters. These flow meters have a capacity of 30 ML/d at 1.53 m W.C. (60.24 in. W.C.).

The newer eight filters are numbered 5 to 12, consecutively. They are piped to eight separate meters. These flow meters have a capacity of 15 ML/d at 1.38 m W.C. (54.32 in. W.C.).

At the present time, the maximum filter rates are set individually at each filter, but can be cut back by a clearwell level override.

B.5 Validity

There are no reported problems with the accuracy of metering at the plant. In recent years, all of the metering has been replaced and upgraded with various modernizing contracts. Much of this work is still ongoing.

The flow data in Table 1.0 of Appendix A shows a consistent and systematic set of information, with no apparent difficulties.

The per capita flow data provided in Table 1.1 of Appendix A includes a fairly high average and maximum daily flow, but this is not surprising, given the extensive and year-long influx of tourists into Niagara Falls.

SECTION C

PROCESS COMPONENTS

SECTION C

PROCESS COMPONENTS

C.1 General

The following drawings are included in Appendix F:

(a) Site and Location Plan dated May 1987
(b) Block Schematic dated May 1987
(c) Dwg. No. E8 Upgrading of Low and HL Stations - P&ID - May 1982
(d) Dwg. No. E1 Filters - P&ID (1) - Sept. 1984
(e) Dwg. No. E2 Filters - P&ID (2) - Sept. 1984
(f) Dwg. No. E3 Filters - P&ID (3) - Sept. 1984
(g) Dwg. No. E4 Filters - P&ID (4) - Sept. 1984
(h) Dwg. No. E5 Washwater - P&ID (5) - Sept. 1984
(i) Dwg. No. CS-6 Low Lift - P&ID - Apr. 1985
(j) Dwg. No. CS-7 High Lift - P&ID - Apr. 1985

This section includes detailed information on Design Data and Chemical Systems.

This section also contains a series of photographs to illustrate the major plant components and chemical feed systems.

C.2 Design Data

(a) Plant Capacity

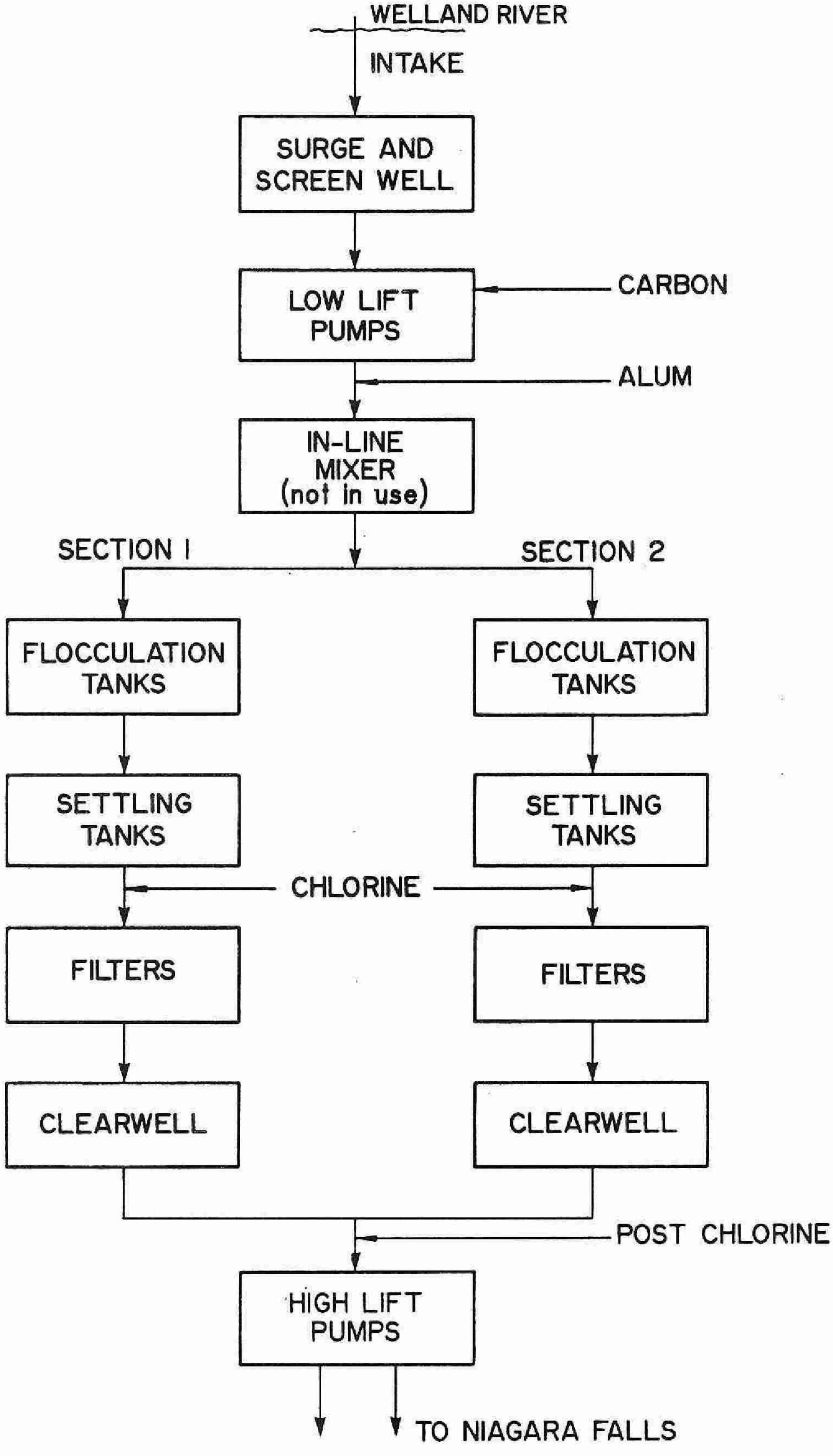
Sections 1 and 2 both contain flocculation, sedimentation and filtration. Section 1 contains Filters 1-4, and Section 2 contains Filters 5-12.

Numerous piping, pumping and instrumentation changes have occurred over the years.

The nominal rated capacity of the facilities is 146 ML/d, with a present average daily flow of about 60 ML/d. All of the operating data presented herein are based on flows of 60 and 146 ML/d. In the past, a higher proportion of the total flow was directed through Section 2 than through Section 1. The Region has made some hydraulic changes, which allows almost equivalent flows through each section. Thus, at present, the Region operates the plant by dividing the flow equally to each section of the plant.

FIGURE I

NIAGARA FALLS WATER TREATMENT PLANT
PROCESS AND PIPING SCHEMATIC



(b) Intake

The intake is concrete, 1220 mm in diameter and 139 m long. Gore & Storrie carried out tests on the intake on 14 January 1980 and established a capacity of 163.7 ML/d and a friction coefficient C=100.

(c) Surge Well

The intake pipe terminates in a concrete surge well just before the travelling water screens. The surge well is divided into two sections 1.5 m X 3.1 m X 2.7 m deep each.

(d) Screening

There are two concrete screen chambers each 3.1 m X 3.7 m X 2.7 m deep.

Each chamber houses a travelling water screen 1.5 m wide with a 9.6 mm mesh. One screen has a stainless steel mesh and the other has a copper mesh. The capacity of each screen is 81.8 ML/d. The screens are manually operated.

The screens are scheduled to be automated in 1987.

(e) Low Lift Pumping

There are two concrete low lift suction chambers each 14.9 m X 2.8 m X 2.7 m deep.

The following pumps are installed:

(e) Low Lift Pumping (cont'd)

NO.	TYPE	CAPACITY ML/d
1	Electric	27.4
2	Electric	45.6 (ea.)
1	Electric	54.5
1	Electric	36.5
	Total Installed	209.6
	Firm Capacity	155.1

A standby Diesel generator is available to run the 54.5 ML/d low lift pump during a power outage. This matches the high lift Diesel pumping capability.

The low lift discharge consists of a common 900 mm diameter header which splits into two 600 mm diameter headers that feed Sections 1 and 2.

(f) In-Line Mixer

There can be two purposes for mixing of chemicals into the main process stream: blending and flash mixing. Blending consists of the distribution of chemicals uniformly throughout the body of the process stream and is characterized by relatively high velocity gradients of greater than 200 sec^{-1} for periods of up to several minutes. Flash mixing addresses the coagulation concept that blending must occur within a very short period of time, a matter of seconds, and this requires very high velocity gradients of greater than 1000 sec^{-1}. It is important to recognize the difference between these two concepts and their process implications. Blending mixing is to ensure that the process components will behave uniformly. Flash mixing has been espoused by some researchers in water chemistry as improving the coagulation process.

The common 900 mm dia. stainless steel low lift pump discharge header contains an in-line mixer. This mixer was taken out of service after Streaming Current Monitor (SCM) tests showed a deterioration of performance while using the mixer.

(g) Flocculation

All flocculation tanks are hydraulic spiral over and under flow and are made of concrete.

The flocculation tanks for Section 1, serving Filters 1-4 consist of 12 tanks, 3.64 m X 3.54 m X 4.57 m deep each. The 12 tanks are arranged as 3 sets of 4 cells in series. The total volume of the flocculation tanks is 710 m^3.

Assuming a 50 percent split of flows between Section 1 and Section 2, the flocculation detention times at 146 and 60 ML/d are 14 and 34 minutes, respectively.

The flocculation tanks for Section 2, serving Filters 5-12, consist of 18 tanks, 3.58 m X 3.58 m X 5.18 m deep each. The 18 tanks are arranged as 3 sets of 6 cells in series. The total volume of the flocculation tanks is 1195 m^3. Assuming a 50 percent split of flows between Section 1 and Section 2, the flocculation detention times at 146 and 60 ML/d are 24 and 57 minutes, respectively.

The mixing velocity gradients in the flocculation tanks have been estimated based on a mixing energy input equivalent to the loss of momentum of the water entering the tanks. This is a conservative estimate of the total mixing, since other energy losses occur during passage of the water from one tank to another. This additional mixing energy could result in G values which are as much as 25 percent higher. The actual energy loss can be obtained from precise hydraulic tests.

Useful flocculation velocity gradients range from 100 to <10 sec^{-1}. A "tapered" or stepped series should be used; the highest mixing is provided initially, progressing through a series of cells of decreasing mixing levels. Additionally, the dimensionless parameter, Gt, which is the product of velocity gradient and the duration of mixing, is a most useful parameter which usually must have values within the range of 10^4 to 10^5.

(g) Flocculation (cont'd)

Estimated Velocity Gradient at 12°C:

Section 1	30 ML/d	73 ML/d
Cell 1	$G = 13\ s^{-1}$	$G = 49\ s^{-1}$
Cells 2-4	$G = 6\ s^{-1}$	$G = 23\ s^{-1}$
Overall	$Gt = 1.6 \times 10^4$	$Gt = 2.6 \times 10^4$

Estimated Velocity Gradient at 12°C:

Section 2	30 ML/d	73 ML/d
Cell 1	$G = 20\ s^{-1}$	$G = 76\ s^{-1}$
Cells 2-6	$G = 9\ s^{-1}$	$G = 34\ s^{-1}$
Overall	$Gt = 3.8 \times 10^4$	$Gt = 6.0 \times 10^4$

There are flow equalization tanks between the flocculation chambers and the settling basins.

(h) Settling

The settling tanks are horizontal cross-flow and are made of concrete.

There are 3 tanks in Section 1, serving Filters 1-4. Each settling tank is 34.1 m X 7.3 m X 4.9 m deep. The total volume and surface areas of the settling tanks are 3660 m^3 and 750 m^2, respectively. Assuming a 50 percent split of flows between Section 1 and Section 2, the settling detention times at 146 and 60 ML/d are 72 and 176 minutes, respectively. For similar flow conditions, the overflow rates are 4.1 and 1.7 m/h, respectively.

There are 3 tanks in Section 2, serving Filters 5-12. Each settling tank is 40.7 m X 7.6 m X 5.8 m deep. The total volume and surface areas of the settling tanks are 5380 m^3 and 930 m^2, respectively. Assuming a 50 percent split of flows between Section 1 and Section 2, the settling detention times at 146 and 60 ML/d are 106 and 260 minutes, respectively. For similar flow conditions, the overflow rates are 3.3 and 1.3 m/h, respectively.

The settled water is discharged into settled water conduits.

(i) Filters

Niagara Falls has 12 filters in total. Filters 1A, 1B, 2A, 2B, 3A, 3B, 4A and 4B were built in 1930 and are now known as Filters 1-4. There are four filter flow meters; one for each pair of filter boxes. The original underdrains for these filters have been replaced with PVC pipe lateral underdrain systems.

The second eight filters were built in 1954 and are known as Filters 5-12. There are eight filter flow meters; one for each filter box. These filters have Leopold underdrains.

All filter boxes are constructed of concrete. Each filter box contains two filter cells.

All filters at Niagara Falls are dual media and have surface agitators. The filters have constant rate controllers with clearwell level override.

FILTERS 1-4 (1930)

	W(m)	L(m)	(1) D(m)	SURFACE AREA (m^2)	GROSS VOL. (m^3)	(2) NET VOL. (m^3)
Each Cell	3.4	7.1	2.3	24.1	55.5	41
16 Cells	-	-	-	386.2	888	656

Notes:

(1) D(m) is depth of water in filter box in metres
(2) Net vol. (m^3) assumes a filter media and underdrain porosity of 0.4. Media depth including drains ranges from 0.940 m to 1.067 m. Approximate make up is as follows:

	Depth (m)
Anthracite	0.432
Sand	0.254
Gravel and Drains	0.457
	1.143

(i) **Filters (cont'd)**

FILTERS 5-12 (1954)

	W(m)	L(m)	(1) D(m)	SURFACE AREA (m^2)	GROSS VOL. (m^3)	(2) NET VOL. (m^3)
Each Cell	3.78	6.32	3.07	23.9	73.3	57.7
16 Cells	-	-	-	382.4	1172.8	923.2

Notes:

(1) D(m) is depth of water in filter box in metres
(2) Net vol. (m^3) assumes a filter media and underdrain porosity of 0.4. Media depth including drains ranges from 1.016 m to 1.168 m. Approximate make up is as follows:

	Depth (m)
Anthracite	0.433
Sand	0.253
Gravel	0.201
Drains	0.265
	1.152

(i) Filters (cont'd)

OPERATING PARAMETERS

Influent Turbidity Range (FTU)	1.9-6.7 based on readings every 4 hours during period Dec/85-Jan/86
Effluent Turbidity Range (FTU)	0.16-0.43 based on readings every 4 hours during period Dec/85-Jan/86
Length of Run	72 hr. (old Filters 1-4) 72 hr. (new Filters 5-12) All based on present average day flows.
Headloss (Max.)	2.0 m

Flow Rate

Total Flow	Split Flow	Filtration Rate Section 1 Filters 1-4	Filtration Rate Section 2 Filters 5-12
146 ML/d	73 ML/d	8.0 m/h	8.0 m/h
60 ML/d	30 ML/d	3.3 m/h	3.3 m/h

Backwash Flow Rate	Low Wash 12 - 16 m/h High Wash 47 m/h
Wash Water/Wash	5.7 - 7.6 m^3/m^2

(j) Clearwells

All clearwells are constructed of concrete.

Clearwells under Filters 1-4	3.6 ML
Clearwells under Filters 5-12	3.3 ML
Total	6.9 ML

(k) High Lift Pumping

All high lift pumps are horizontal centrifugal.

NO.	TYPE	CAPACITY ML/d
2	Electric	27.4
2	Electric	45.6
1	Elec. or Diesel	54.5
	Total Installed	200.5
	Firm Capacity	146

(l) Backwash Treatment

Presently, the plant has no waste treatment facilities. The backwash water is drained directly back to the Niagara River, approximately 400 to 500 metres downstream of the intake.

(m) Sludge Disposal

The settling tank sludges drain at least twice annually to the Niagara River.

C.3 Chemical Systems

(a) Disinfectant

Chlorine is stored as a liquid in 0.9 tonne cylinders.

Application points:

Pre- In the settled water conduits, between the settling tanks and the filters. (Section 1 and Section 2 each have a pre-chlorine application point).

Post- High lift pump suction, after the clearwells.

Equipment:

Pre- 1 - 225 kg/d gas chlorinator with 136 kg/d rotometer
1 - 225 kg/d gas chlorinator with 34 kg/d rotometer

Post- 1 - 225 kg/d gas chlorinator with 34 kg/d rotometer
1 - 225 kg/d gas chlorinator with 22 kg/d rotometer

The combined total feed rate from the chlorinators could be 226 kg/d, for a total dosage of 1.5 to 3.75 mg/L for 146 and 60 ML/d flow rates, respectively.

Common 1 - scale with two 0.9 tonne cylinders, one duty and one standby.

The single chlorine cylinder limits the gas withdrawal, without evaporators, to about 435 kg/d, for a total dosage of 3 to 7.25 mg/L for 146 and 60 ML/d flow rates, respectively.

(b) Coagulant

Liquid alum is stored in one 35,350 L PVC-lined wood stave tank.

There are two Wallace & Tiernan metering pumps. The pumps have electrical stroke adjustment for dosage, which is presently operated manually, and speed control for flow pacing. One pump has a capacity of 9500 L/d and the other, 4900 L/d. The maximum dosage capacities are 22 and 42 mg/L for 146 ML/d, and 53 and 103 mg/L for 60 ML/d, for the small and large metering pumps, respectively.

The application point is in the raw water discharge header just before the in-line blender. As discussed before, the in-line blender is not being used.

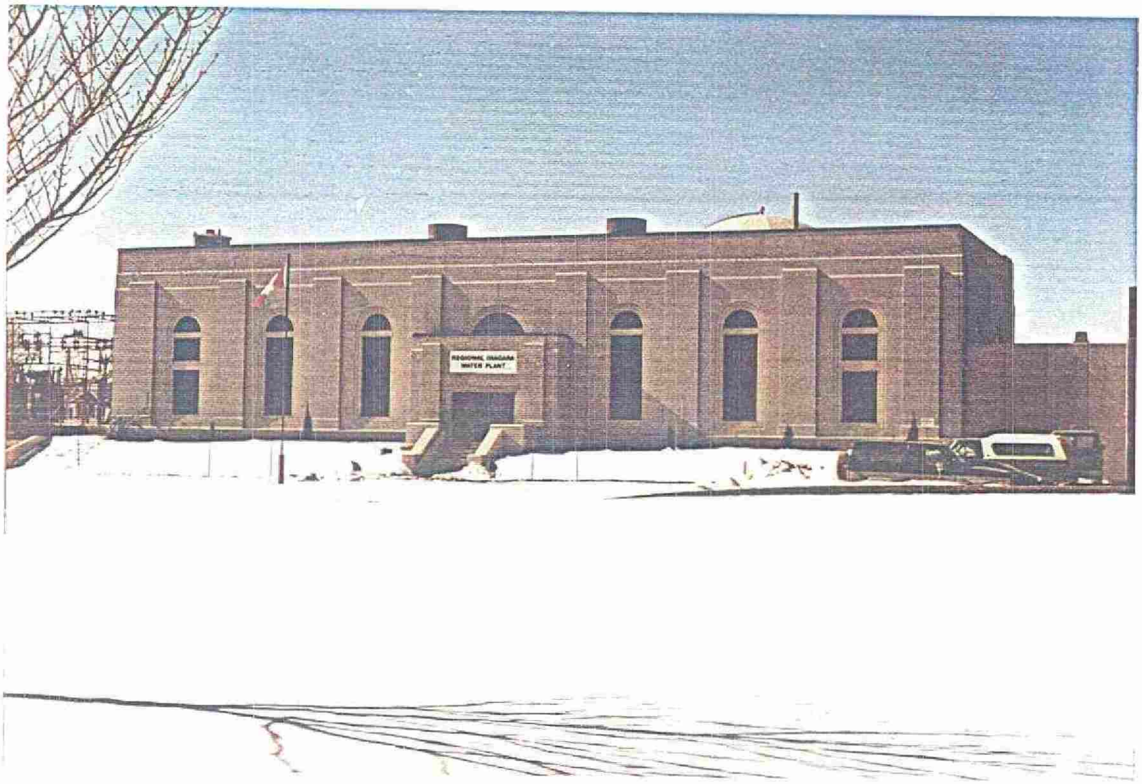
(c) Taste and Odour

Powdered activated carbon is stored in bags. It is loaded manually into a dry feeder. The capacity of the feeder is 785 kg/d. Thus, the maximum dosages are 5.4 to 13 mg/L for 146 and 60 ML/d flows, respectively.

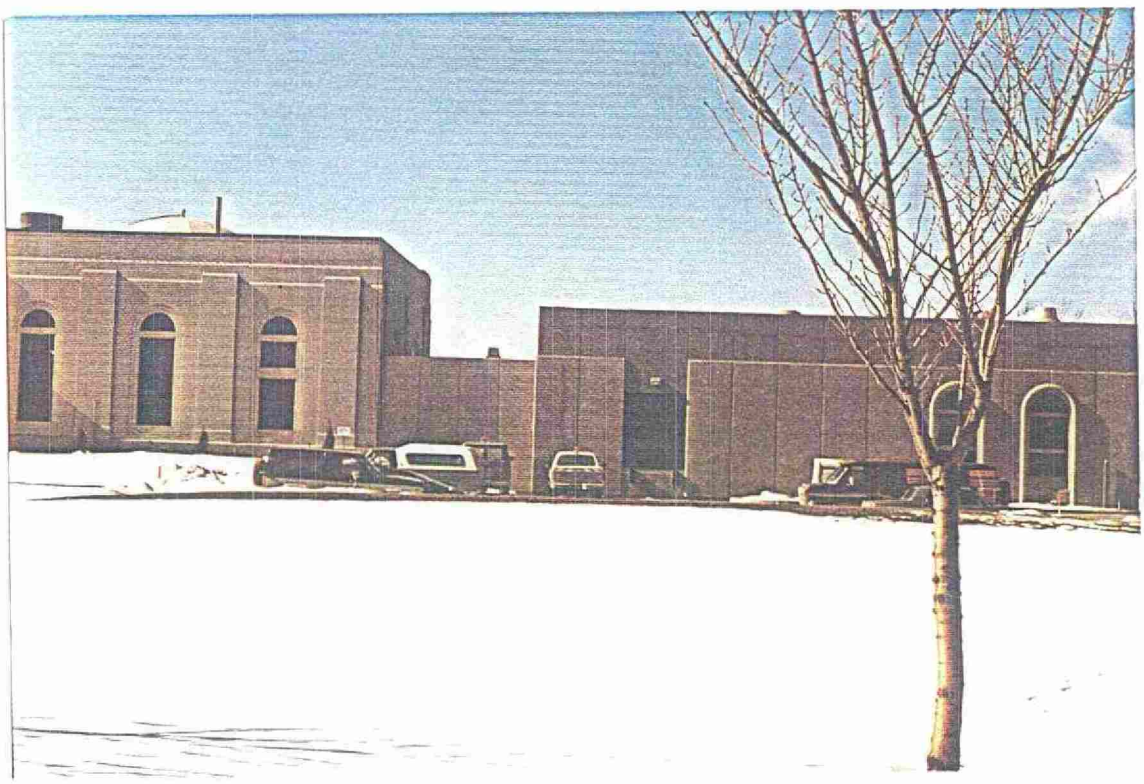
PAC is normally applied in the channel between the screens and the low lift suction well. However, during last season, the PAC solution line became plugged and a new application point was installed into the low lift suction well.

C.4 Photographs

Following is a series of photographs to illustrate major components and chemical feed systems.

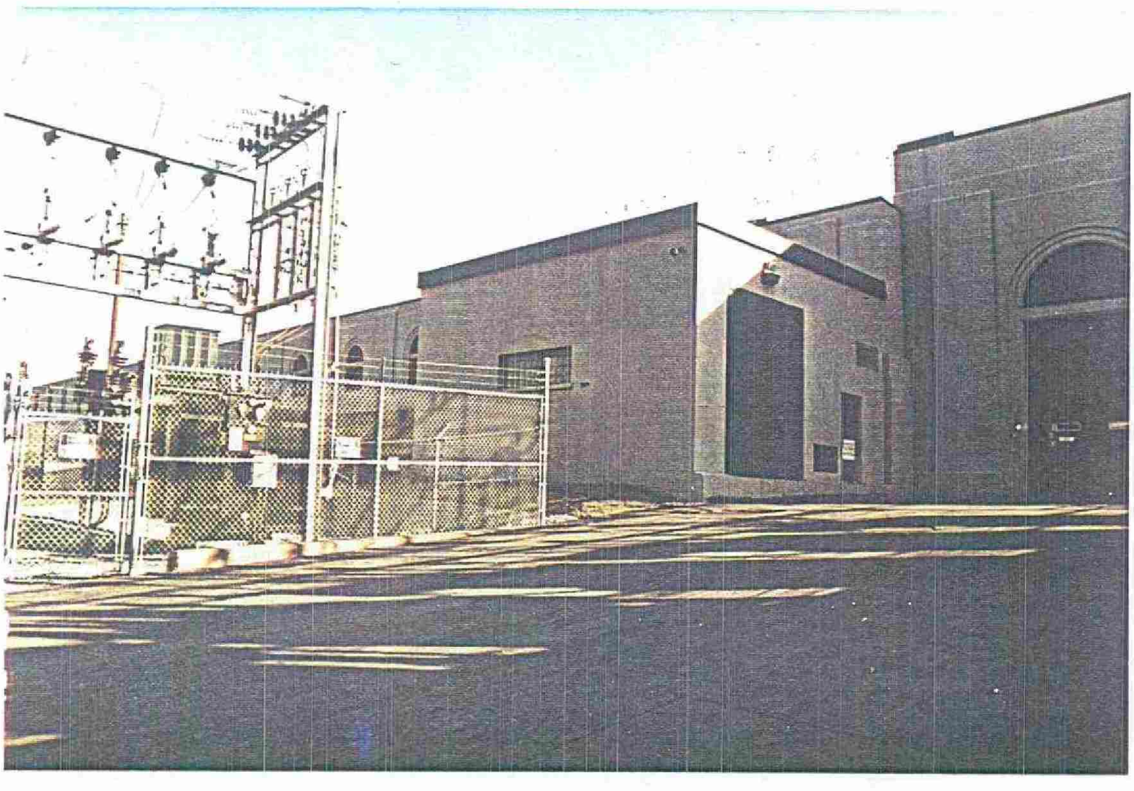


NIAGARA FALLS WATER TREATMENT PLANT



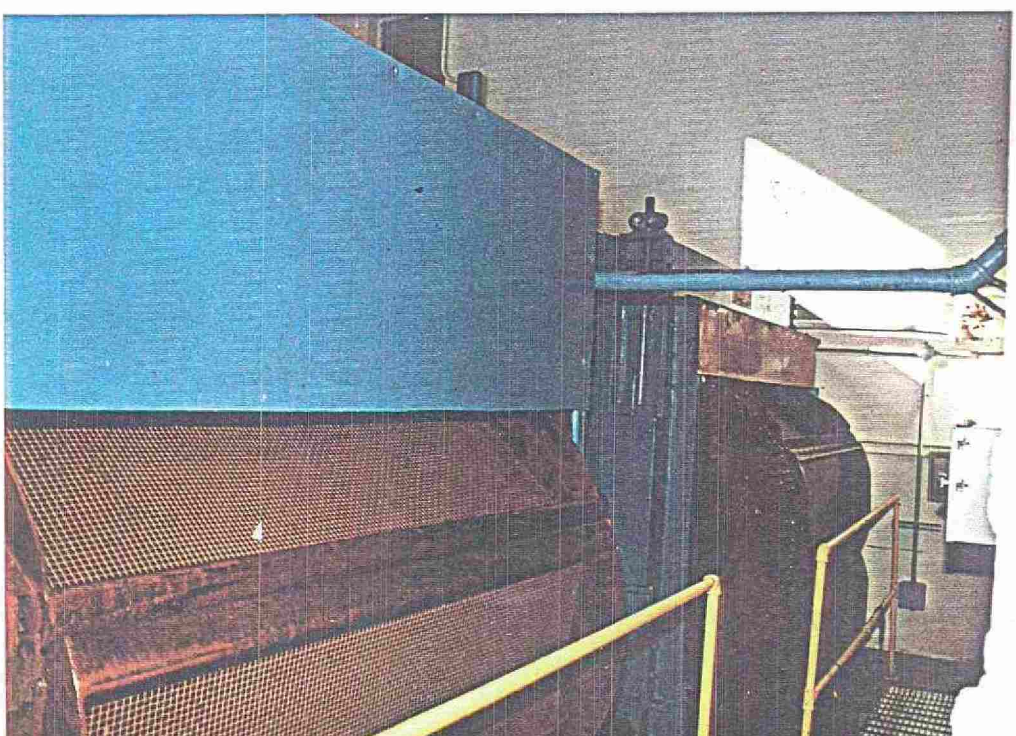
NIAGARA FALLS WATER TREATMENT PLANT -
LOW LIFT PUMPING STATION AT RIGHT

MAIN ENTRANCE WAY



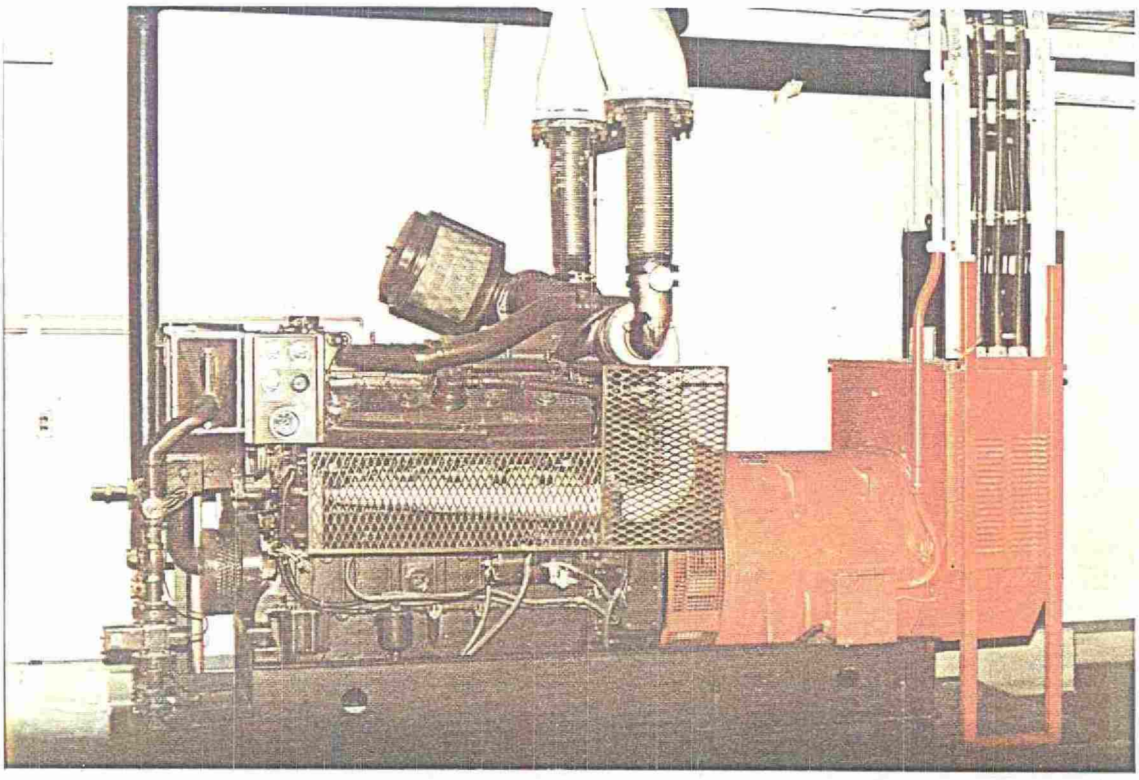
TRANSFORMER STATION ADJACENT TO PLANT

NORTH ELEVATION

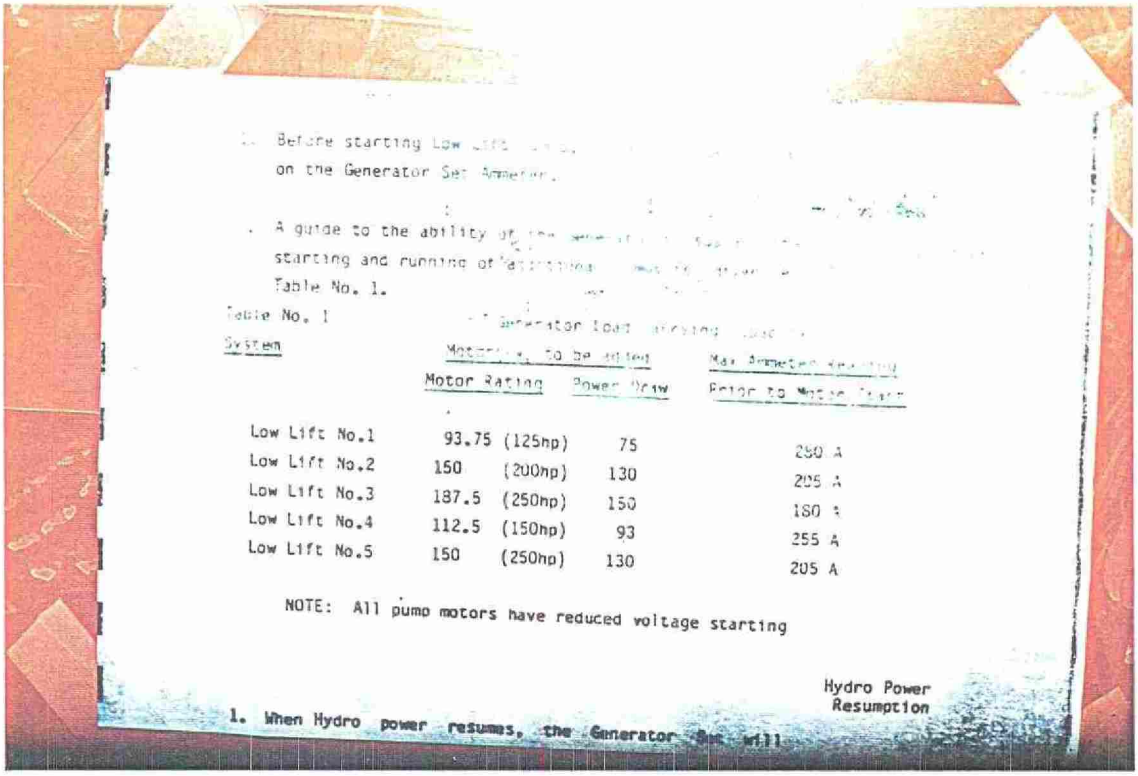


TRAVELLING WATER SCREENS

LOW LIFT PUMPING STATION



GENERATOR FOR LOW LIFT PUMPS



Before starting Low Lift

on the Generator Set Ammeter.

A guide to the ability of the

starting and running of

Table No. 1.

Table No. 1

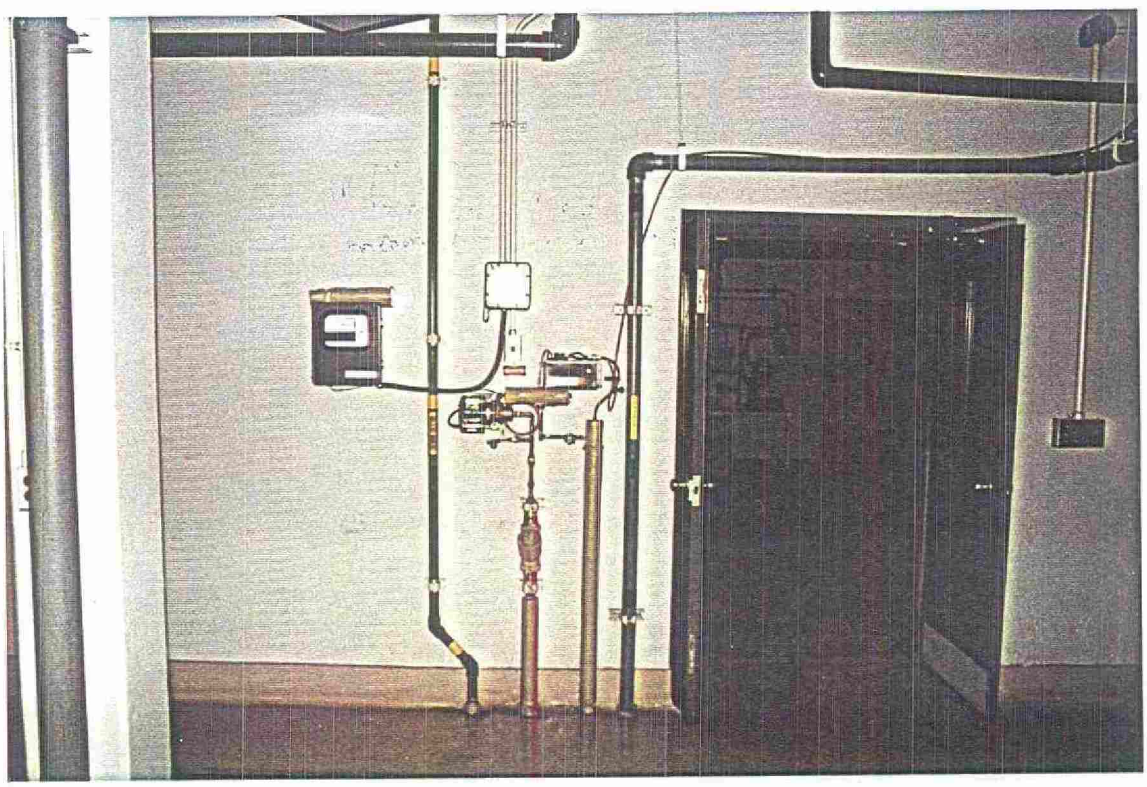
System	Motor Rating	Power Draw	Max Ammeter Reading Prior to Motor Start
Low Lift No.1	93.75 (125hp)	75	250 A
Low Lift No.2	150 (200hp)	130	205 A
Low Lift No.3	187.5 (250hp)	150	180 [illegible]
Low Lift No.4	112.5 (150hp)	93	255 A
Low Lift No.5	150 (250hp)	130	205 A

NOTE: All pump motors have reduced voltage starting

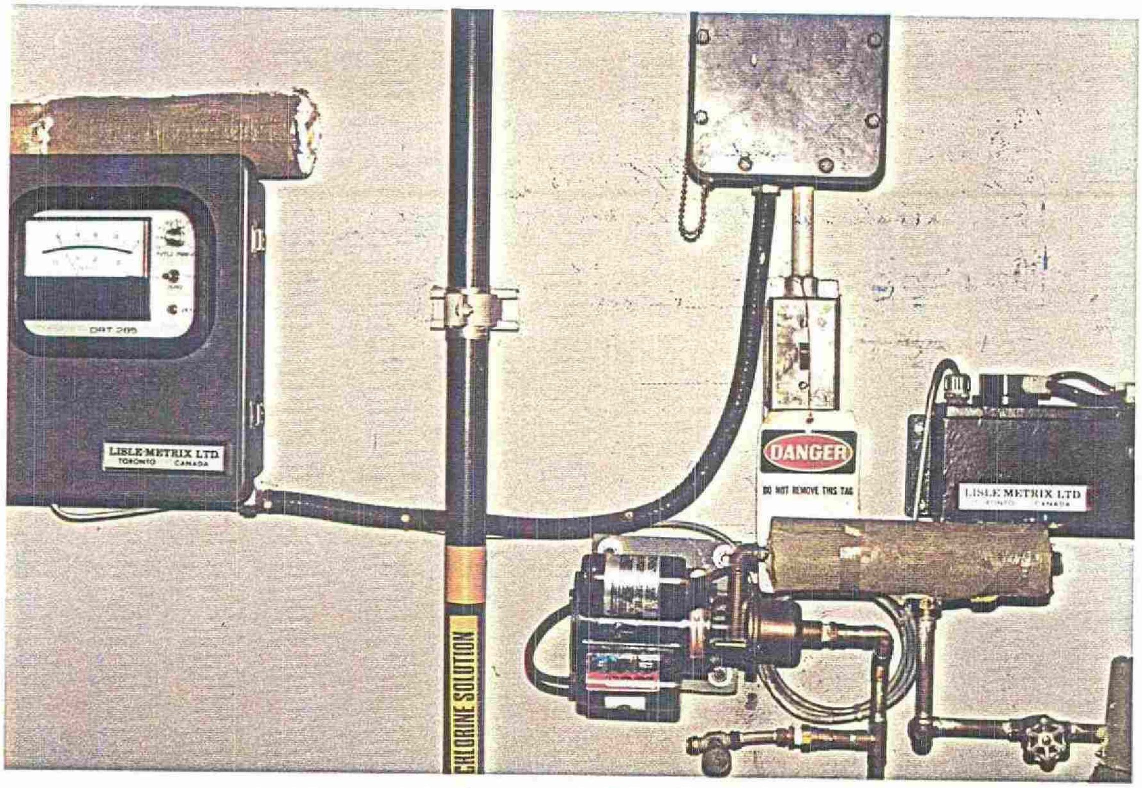
Hydro Power Resumption

1. When Hydro power resumes, the Generator Set will

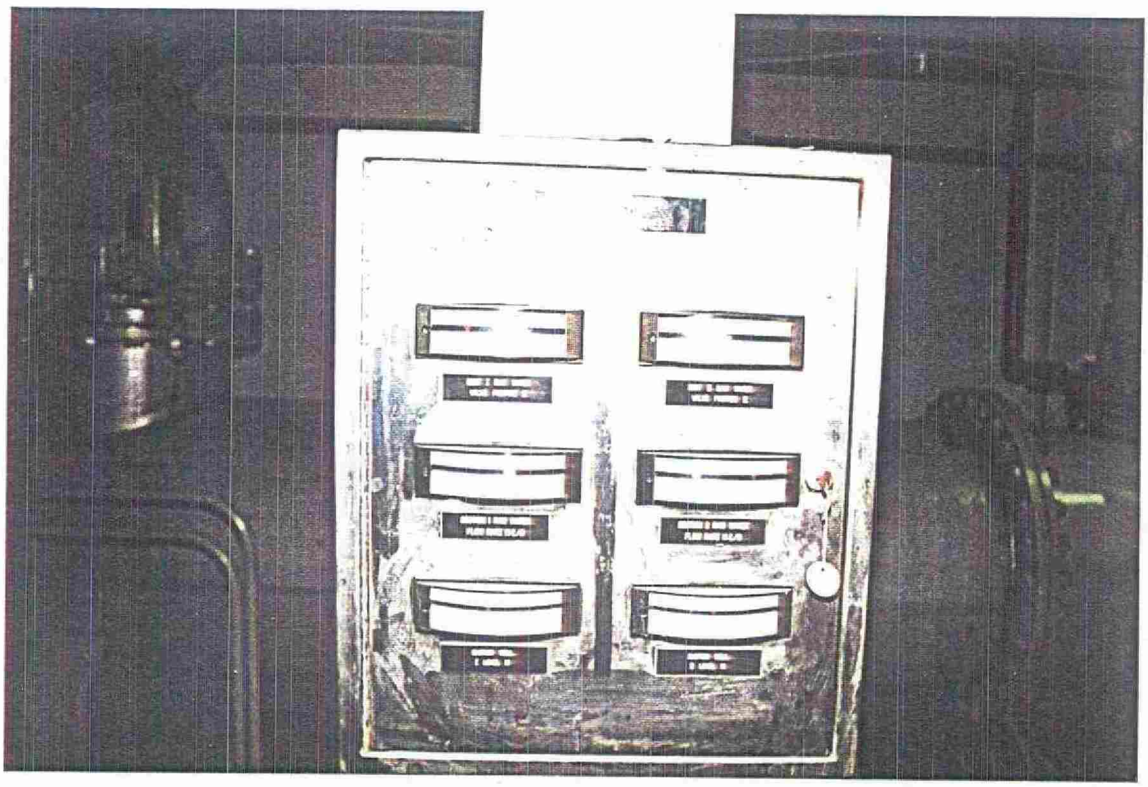
INSTRUCTIONS FOR LOW LIFT GENERATOR



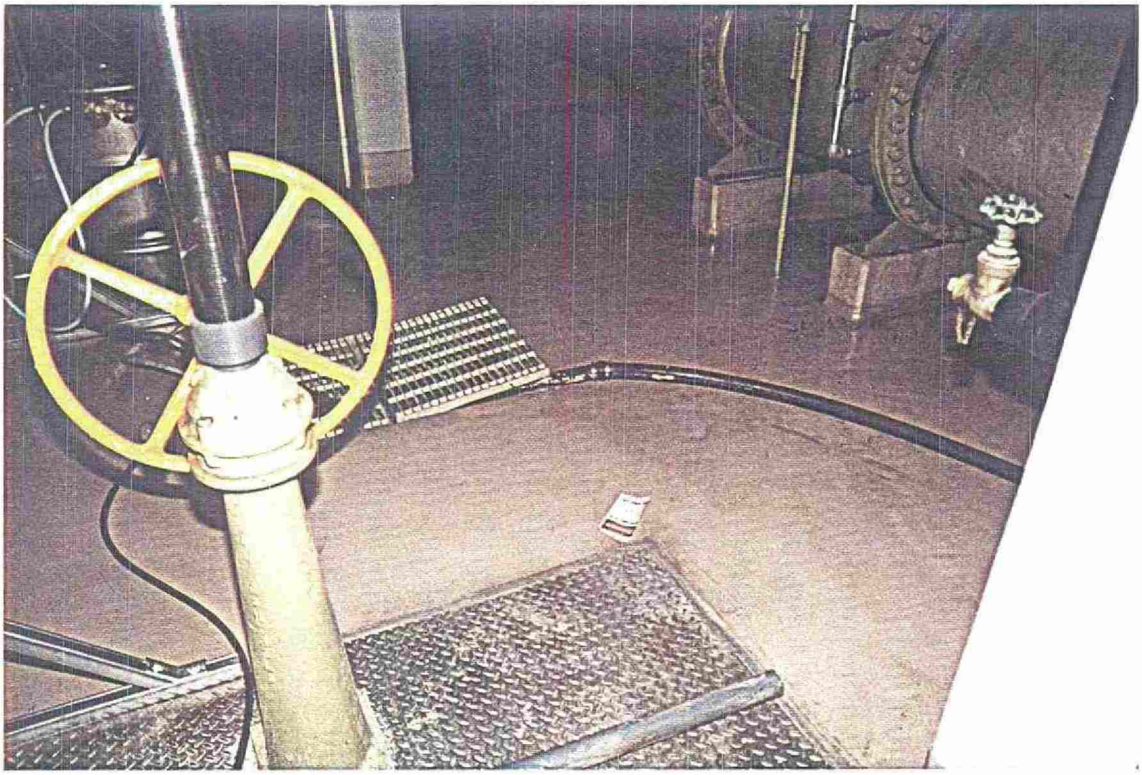
CONTINUOUS RAW WATER TURBIDITY METER,
PRE-CHLORINE LINE AT LEFT (NOT CURRENTLY USED)
PAC LINE AT RIGHT (NOT CURRENTLY USED)



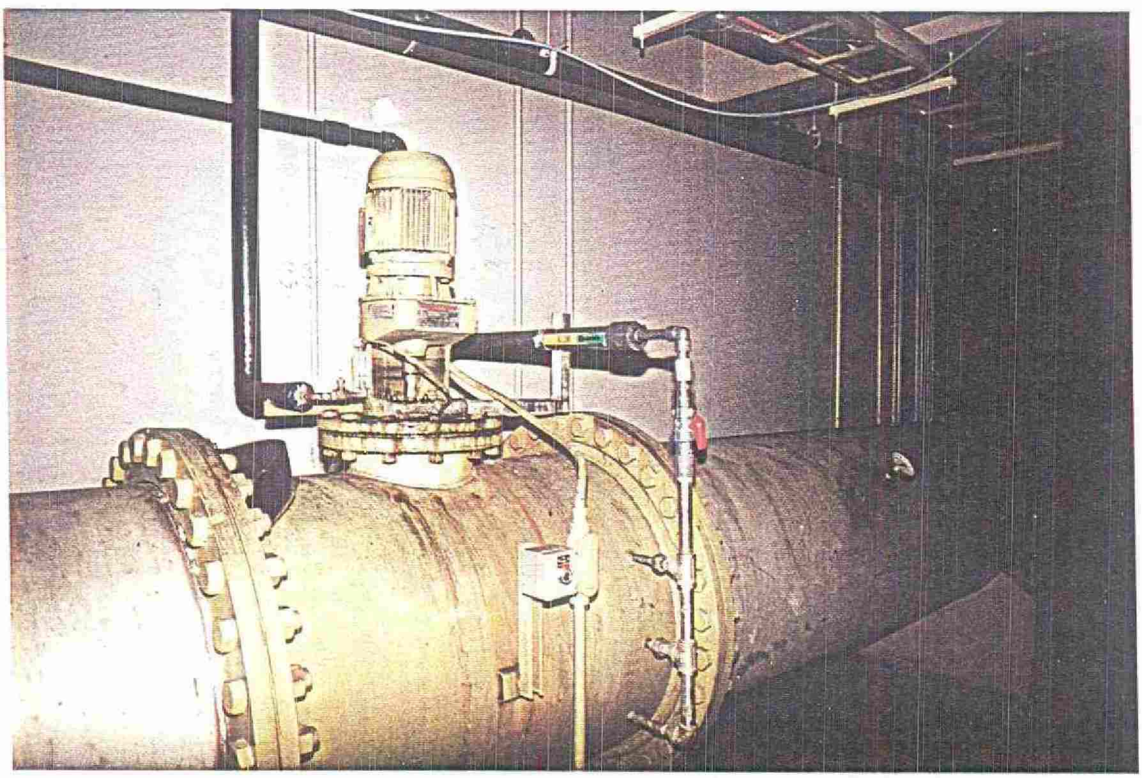
CONTINUOUS RAW WATER TURBIDITY METER



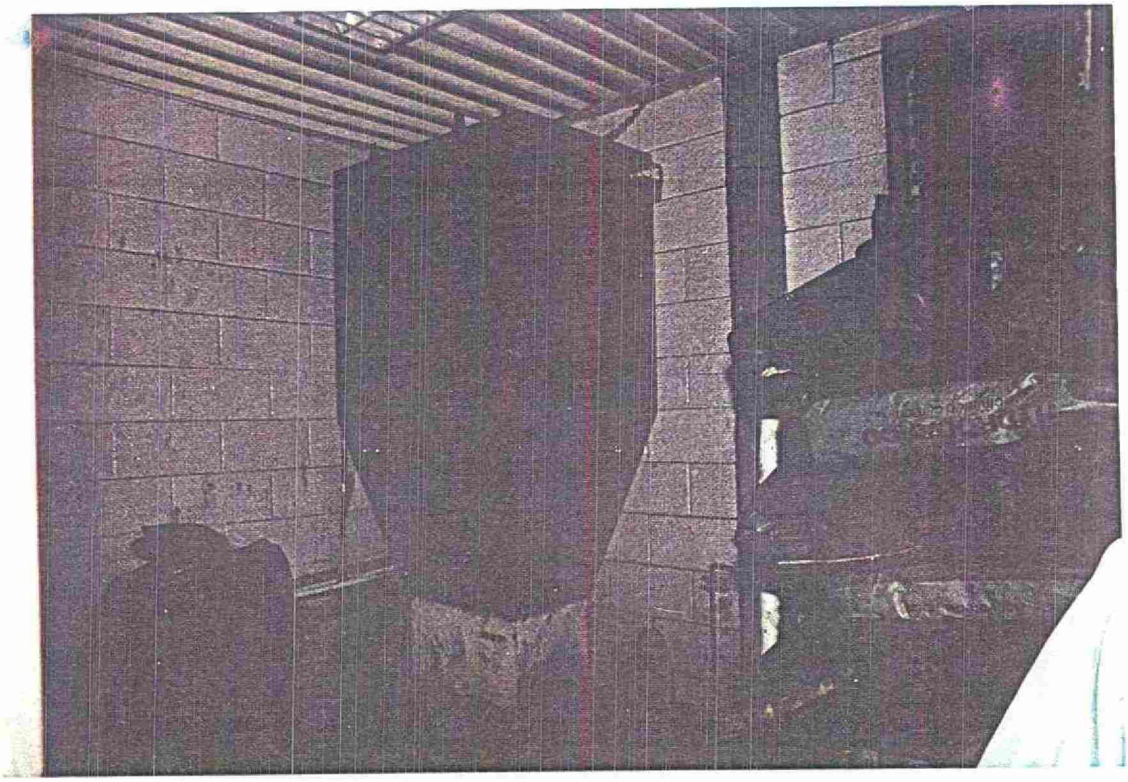
RAW WATER INDICATOR PANEL



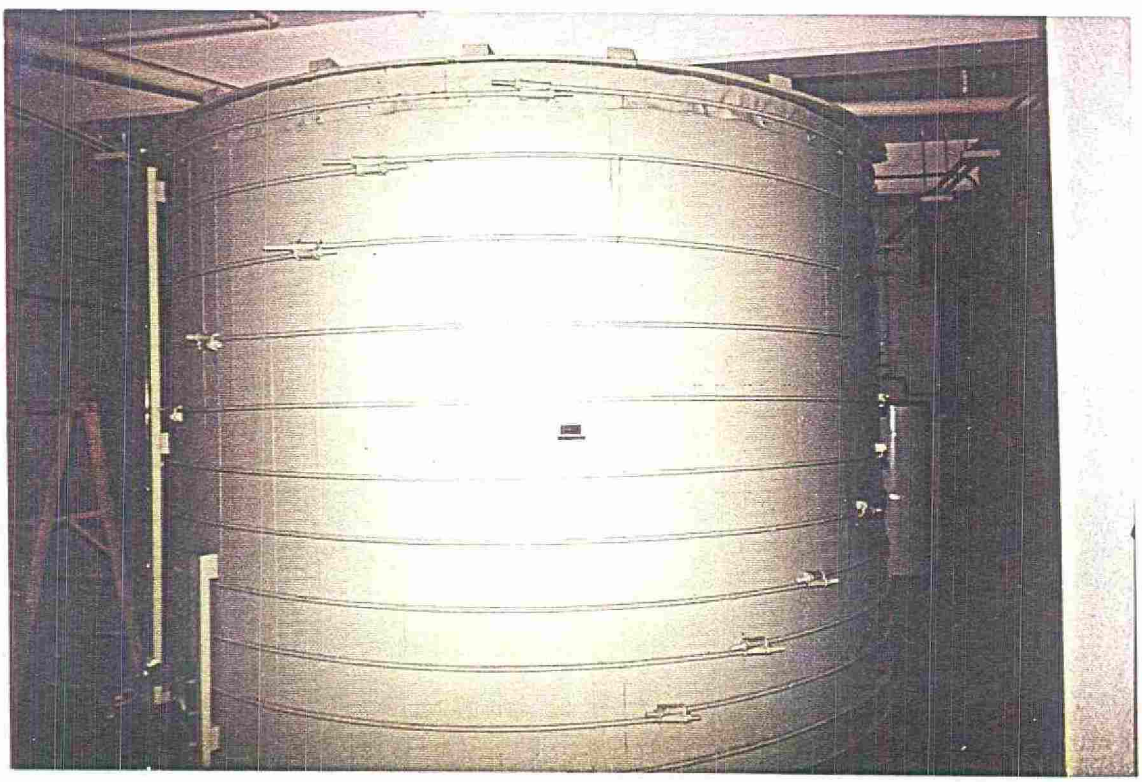
PAC ADDITION POINT (BLACK HOSE AT CENTER)



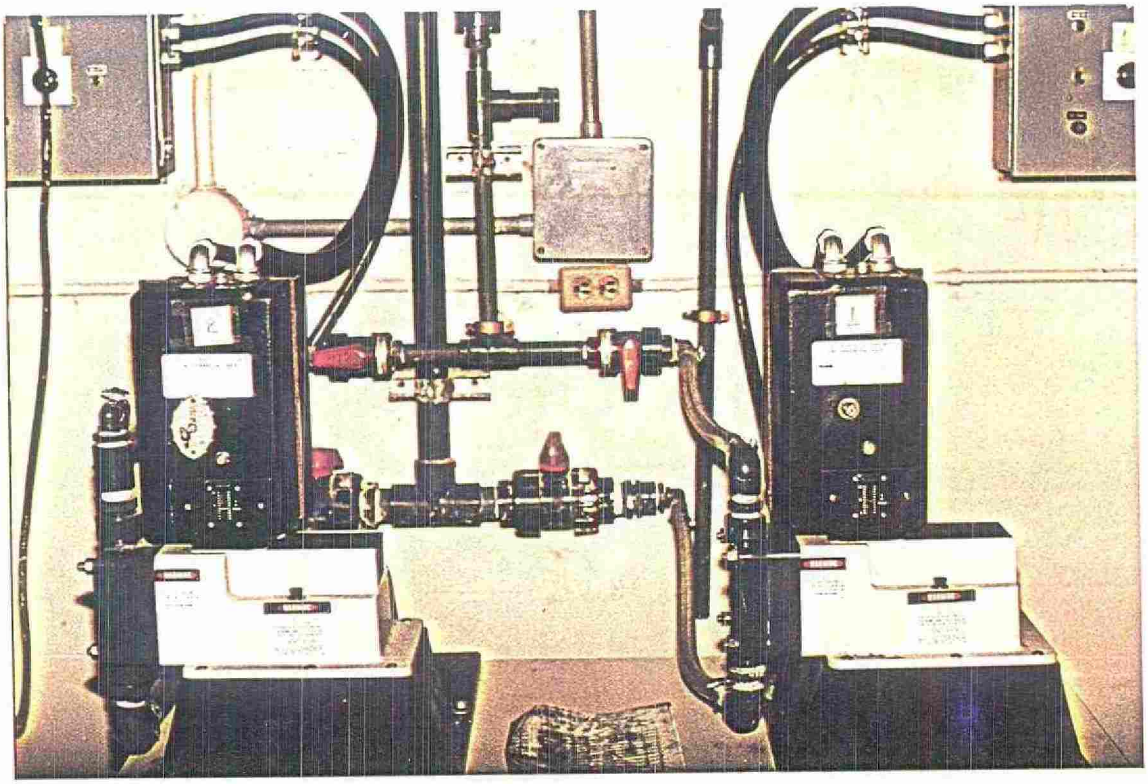
INLINE BLENDER - (not used) - AT ALUM ADDITION POINT
ALSO NOTE TEMPERATURE INDICATOR AT RIGHT



PAC FEED HOPPER

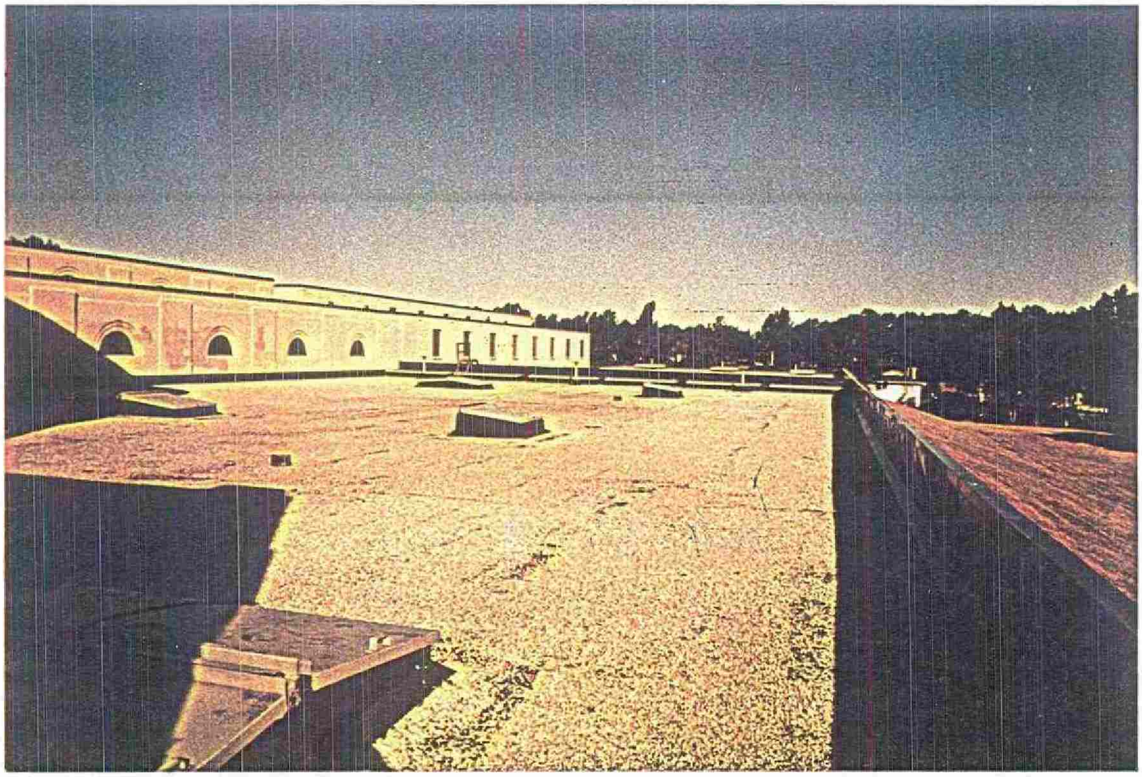


LIQUID ALUM STORAGE TANK



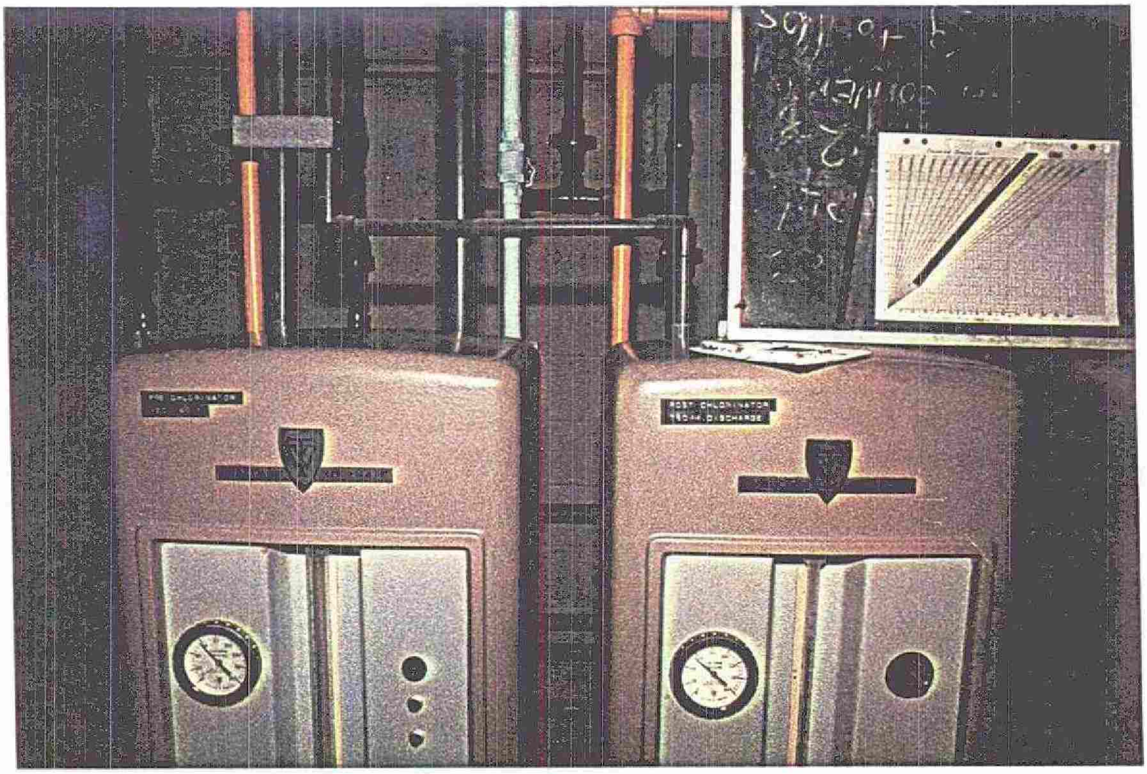
ALUM PUMPS

ALUM PUMP CONTROL

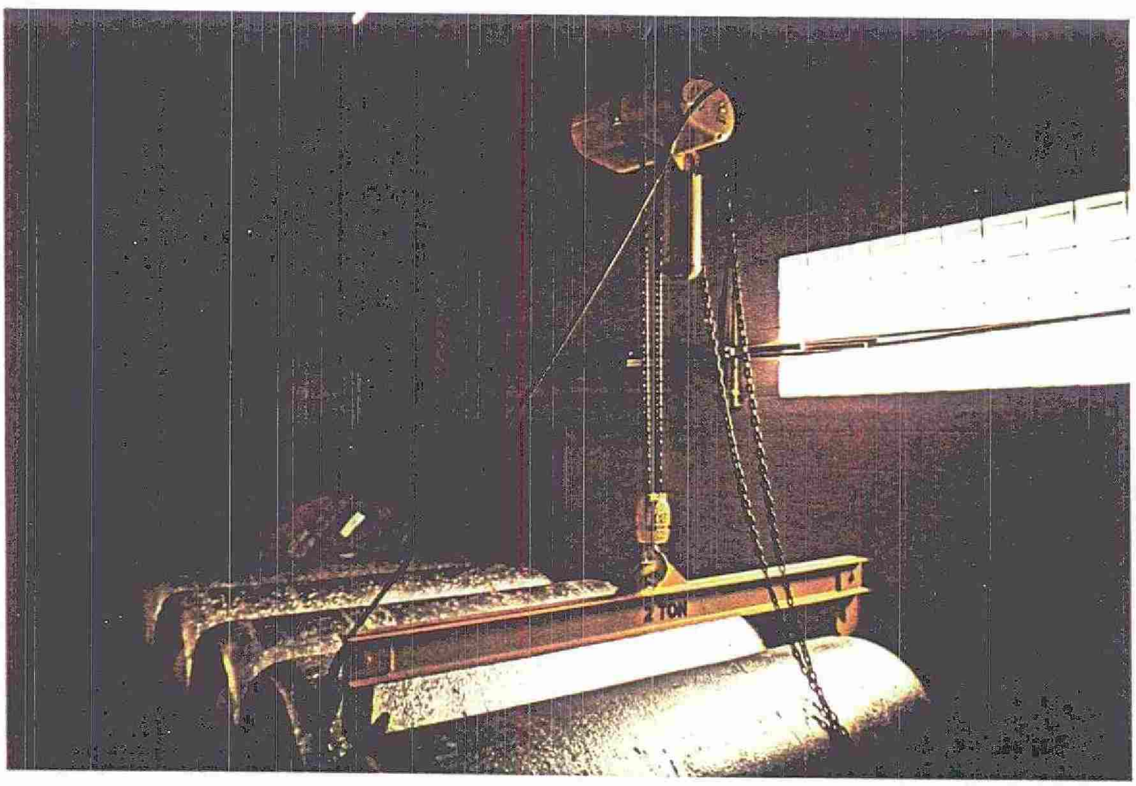


ROOF OVER FLOC TANKS AND SETTLING TANKS

PRECHLORINATOR SECTION NO. 2 AT RIGHT,
POSTCHLORINATOR 900 mm DISCHARGE MAIN AT LEFT

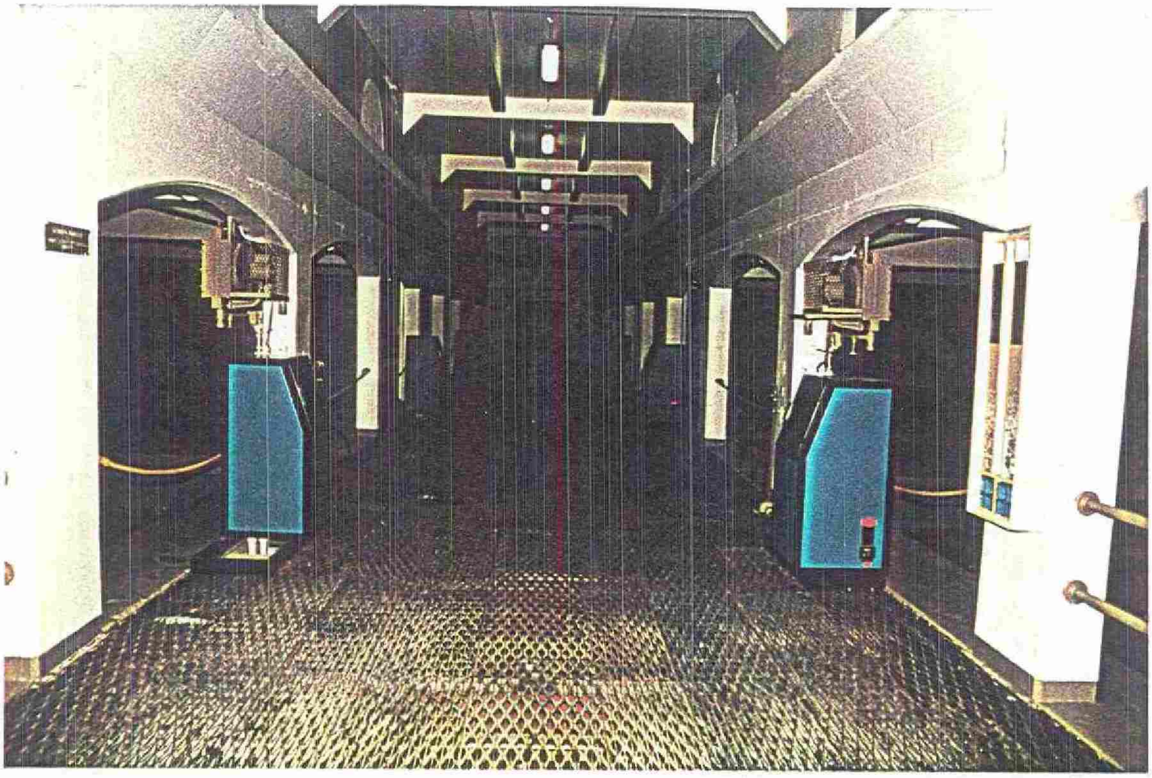


PRECHLORINATOR SECTION NO. 1 AT LEFT,
POSTCHLORINATOR 750 mm DISCHARGE AT RIGHT

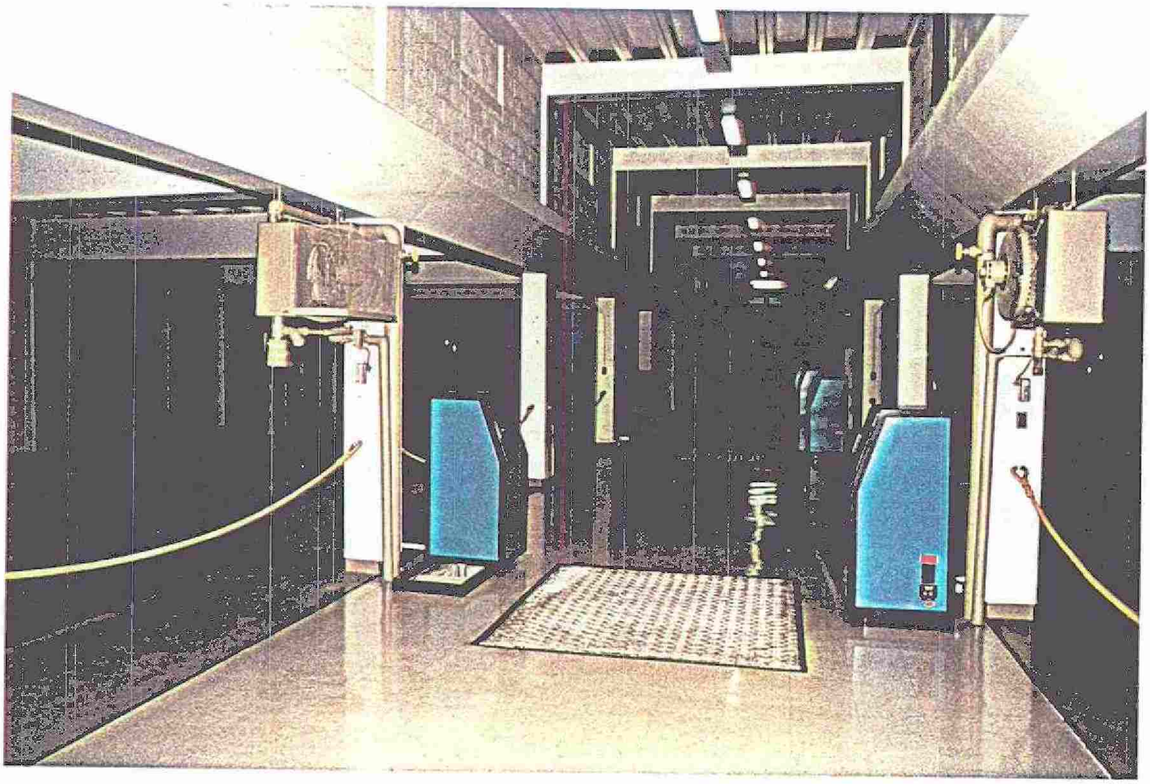


CHLORINE CYLINDERS

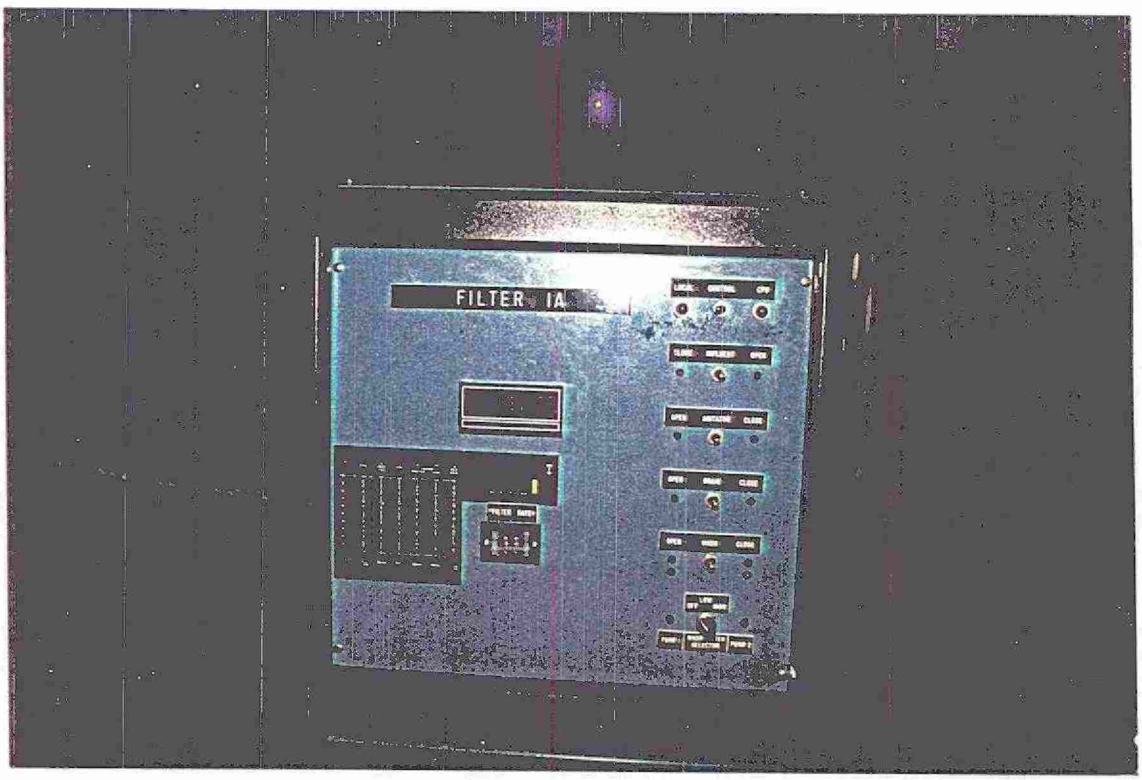
WEIGH SCALE FOR CHLORINE CYLINDERS



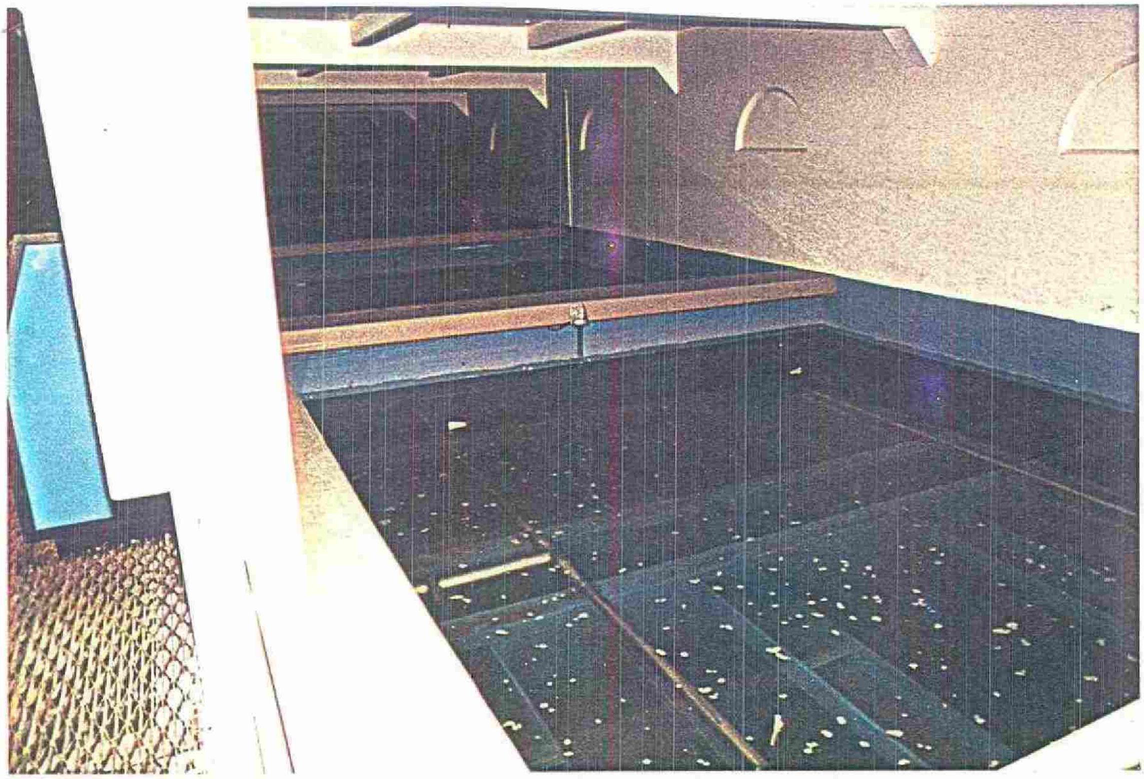
FILTER GALLERY - SECTION 1



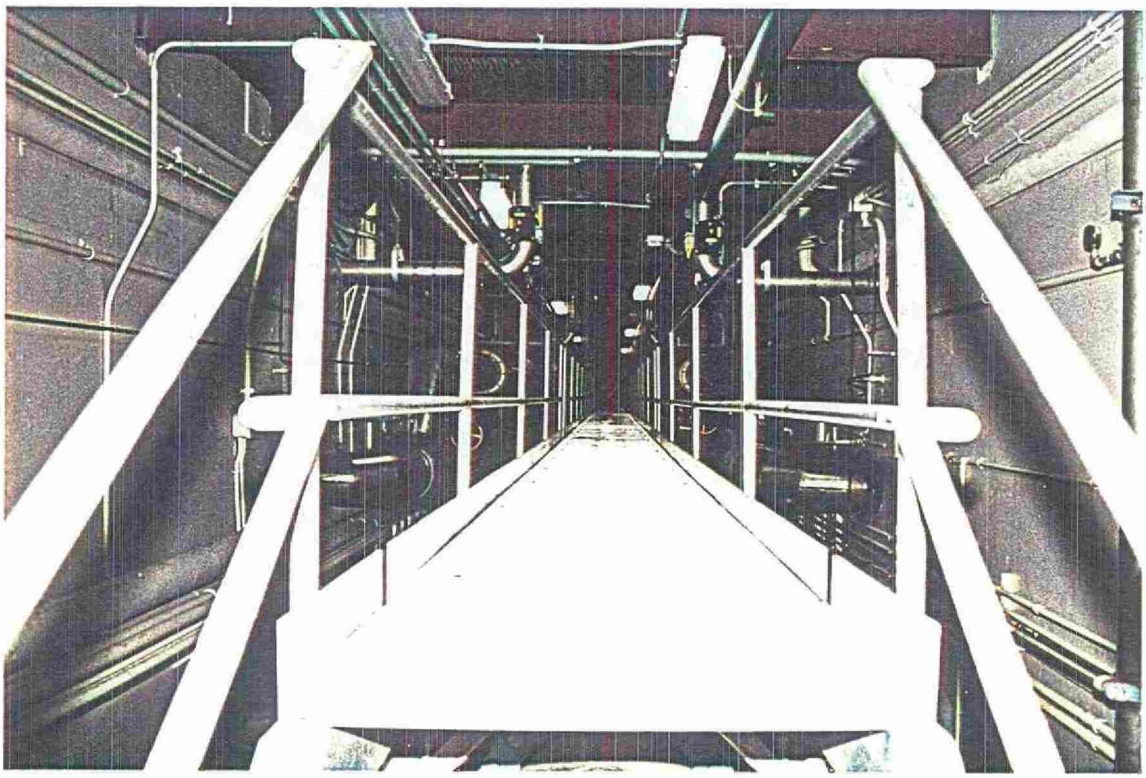
FILTER GALLERY - SECTION 2



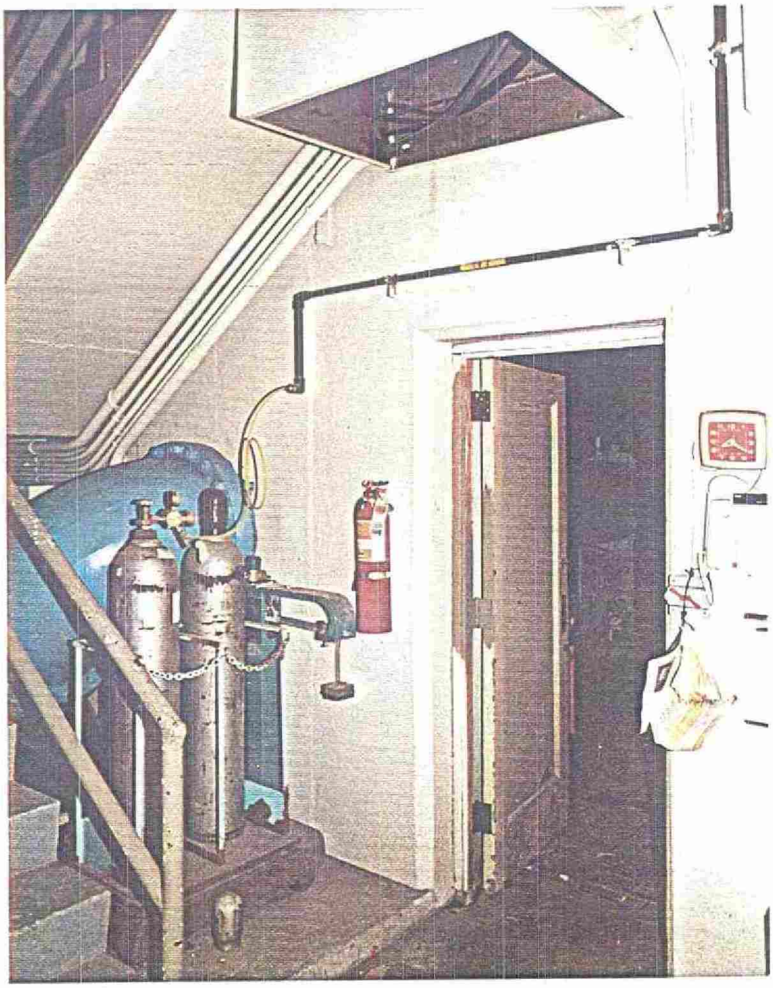
FILTER CONTROLS



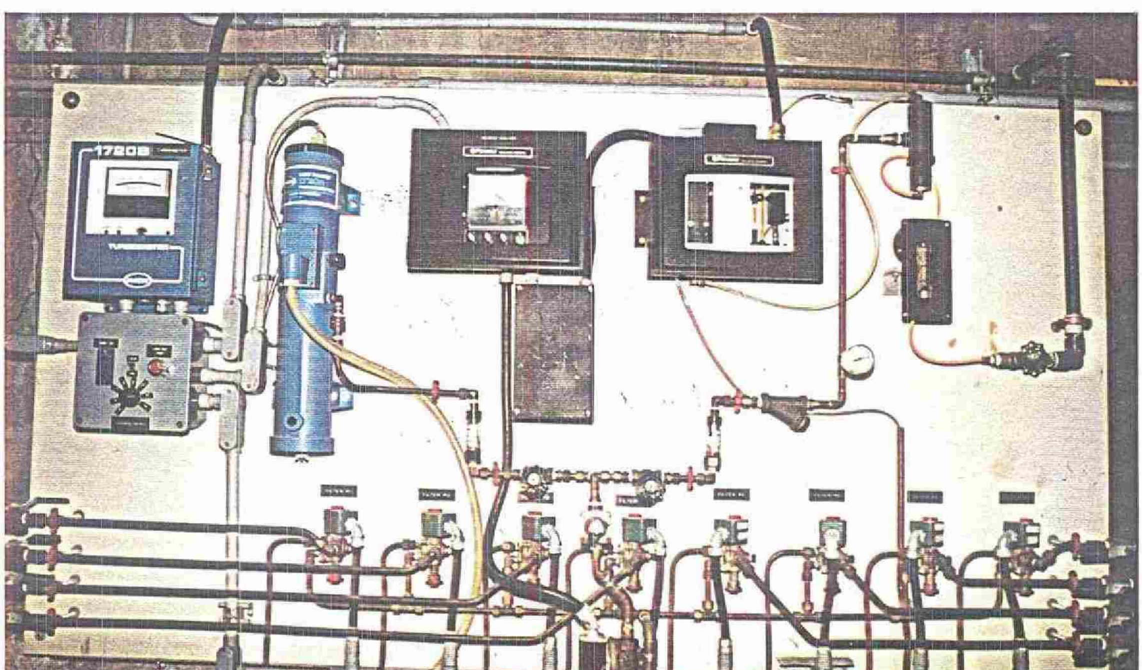
FILTER



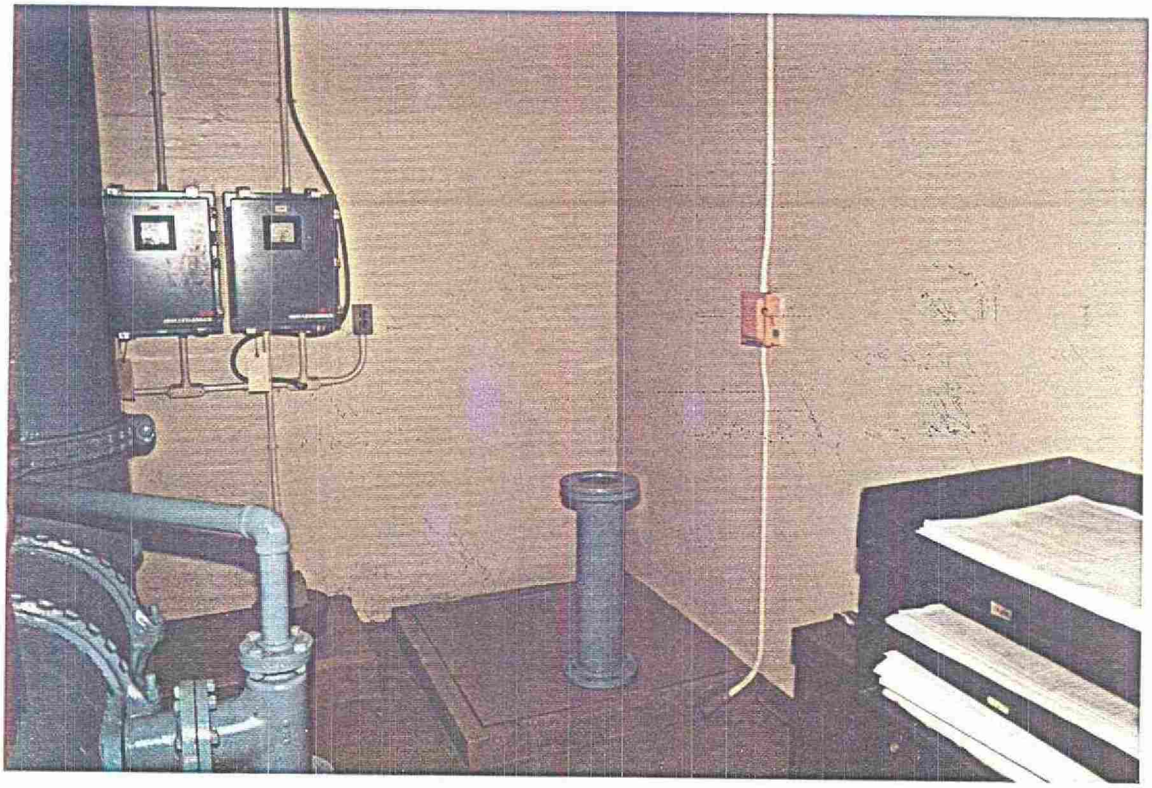
PIPE GALLERY



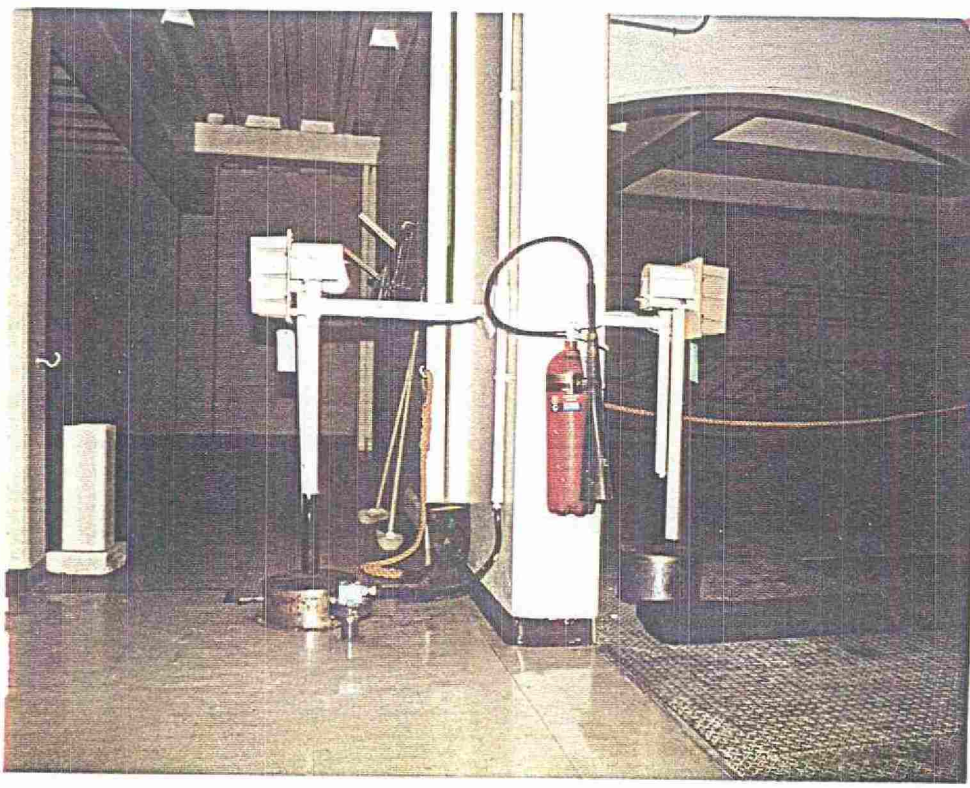
CARBON DIOXIDE SUPPLY FOR CHLORINE RESIDUAL ANALYZER



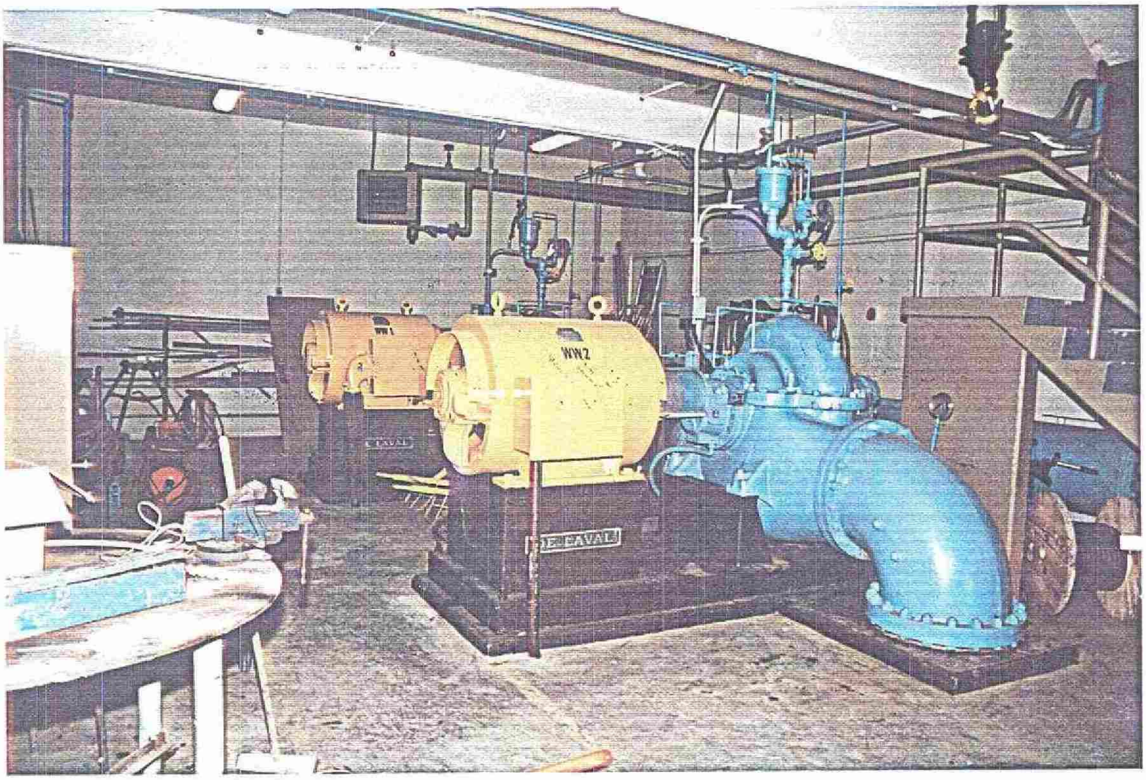
FILTER EFFLUENT TURBIDITY AND
CHLORINE RESIDUAL MONITORING STATION (TYPICAL)



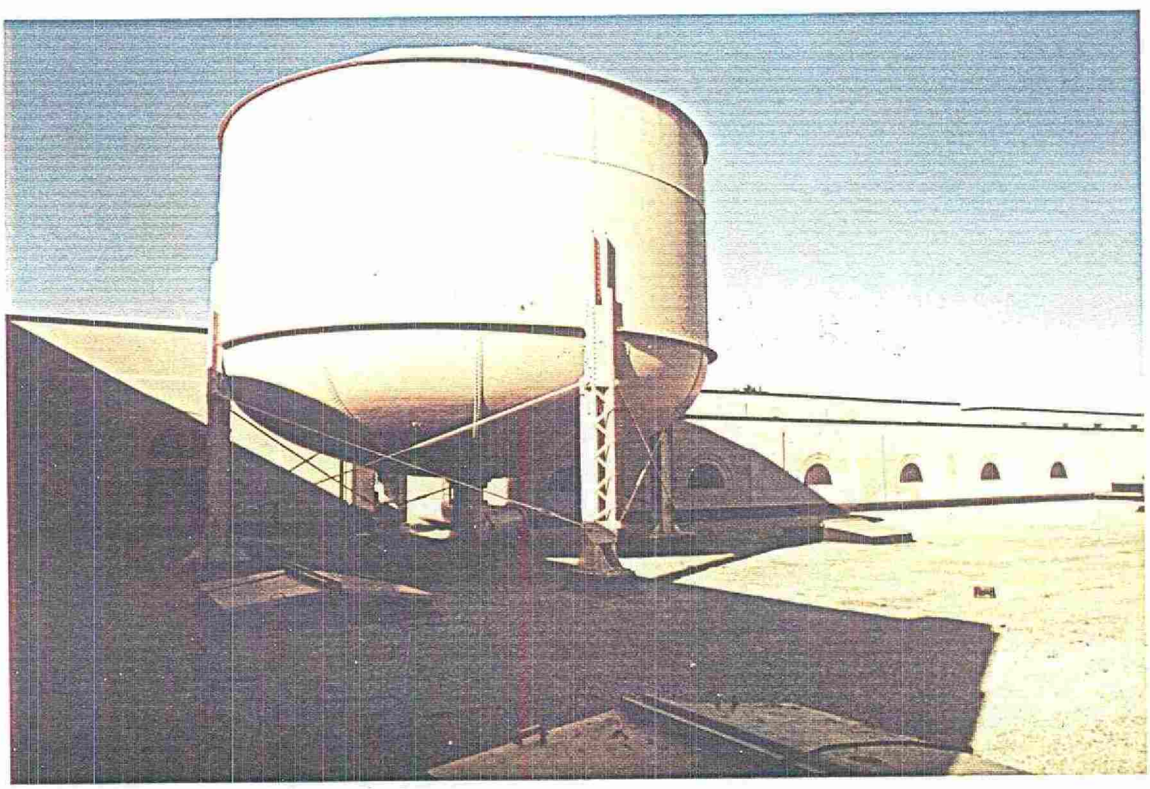
CLEARWELL OBSERVATION PORT



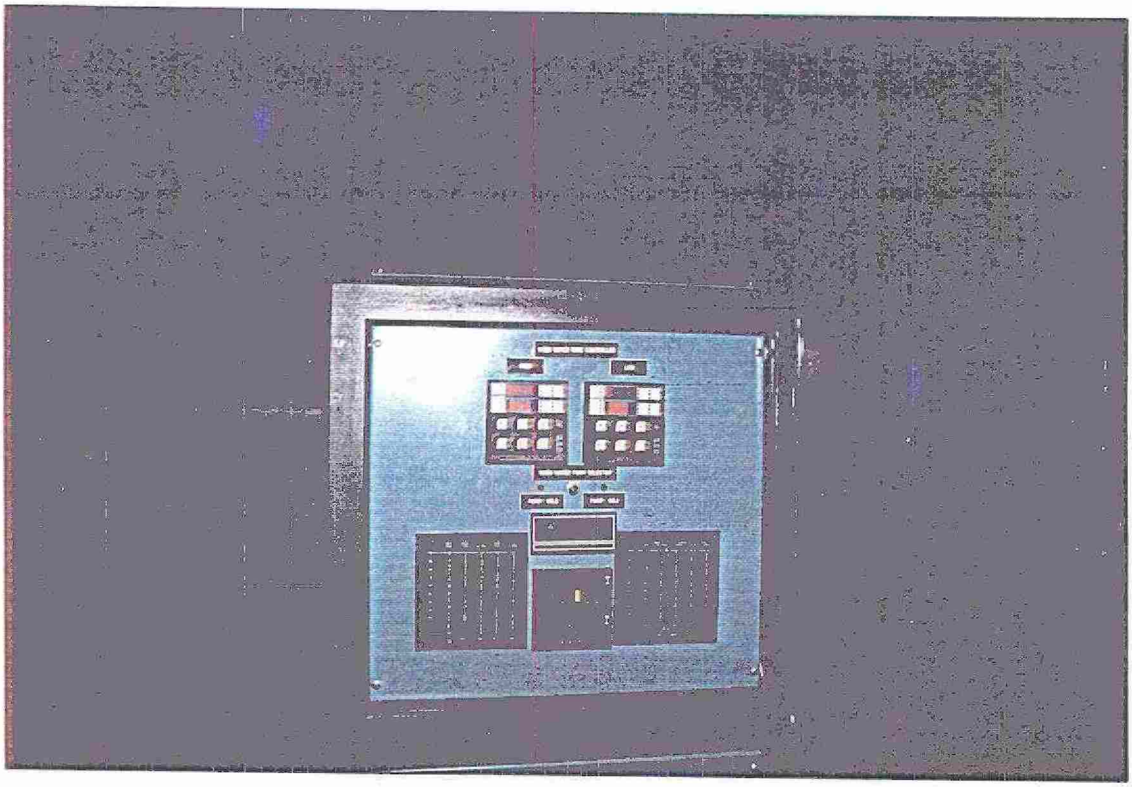
CLEARWELL LEVEL INDICATORS
(SECTION 2 AT LEFT, SECTION 1 AT RIGHT)



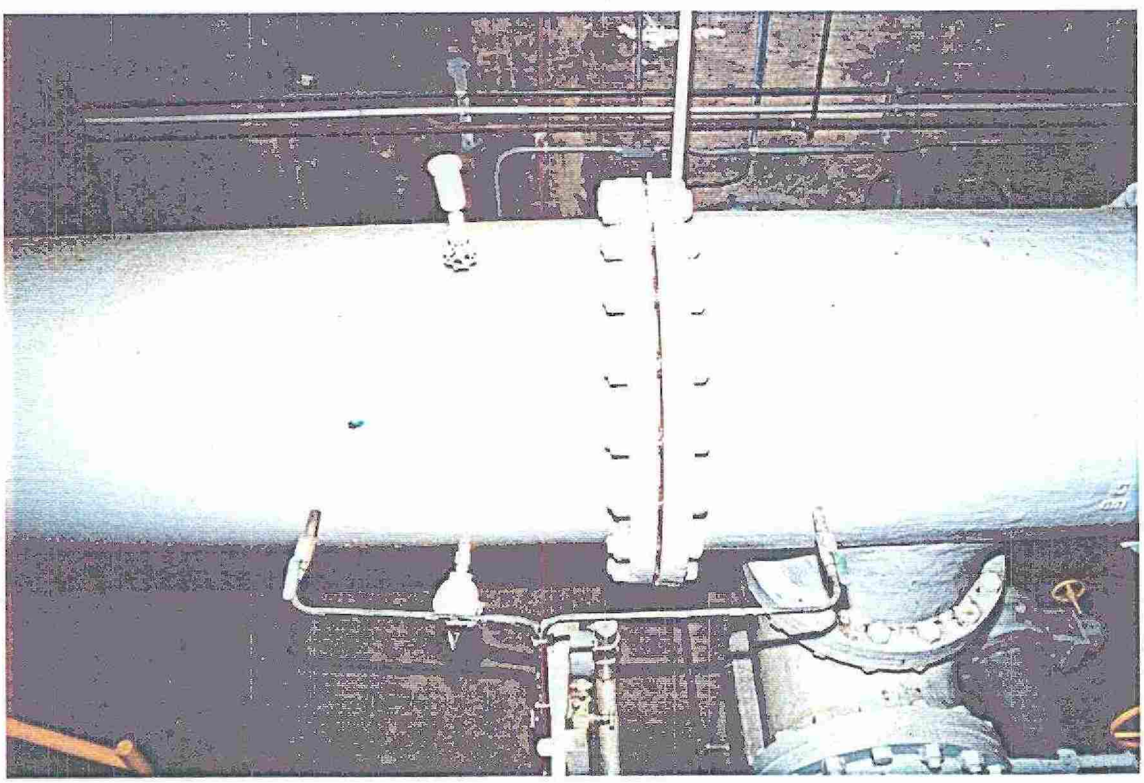
WASH WATER PUMPS



WASH WATER TANK

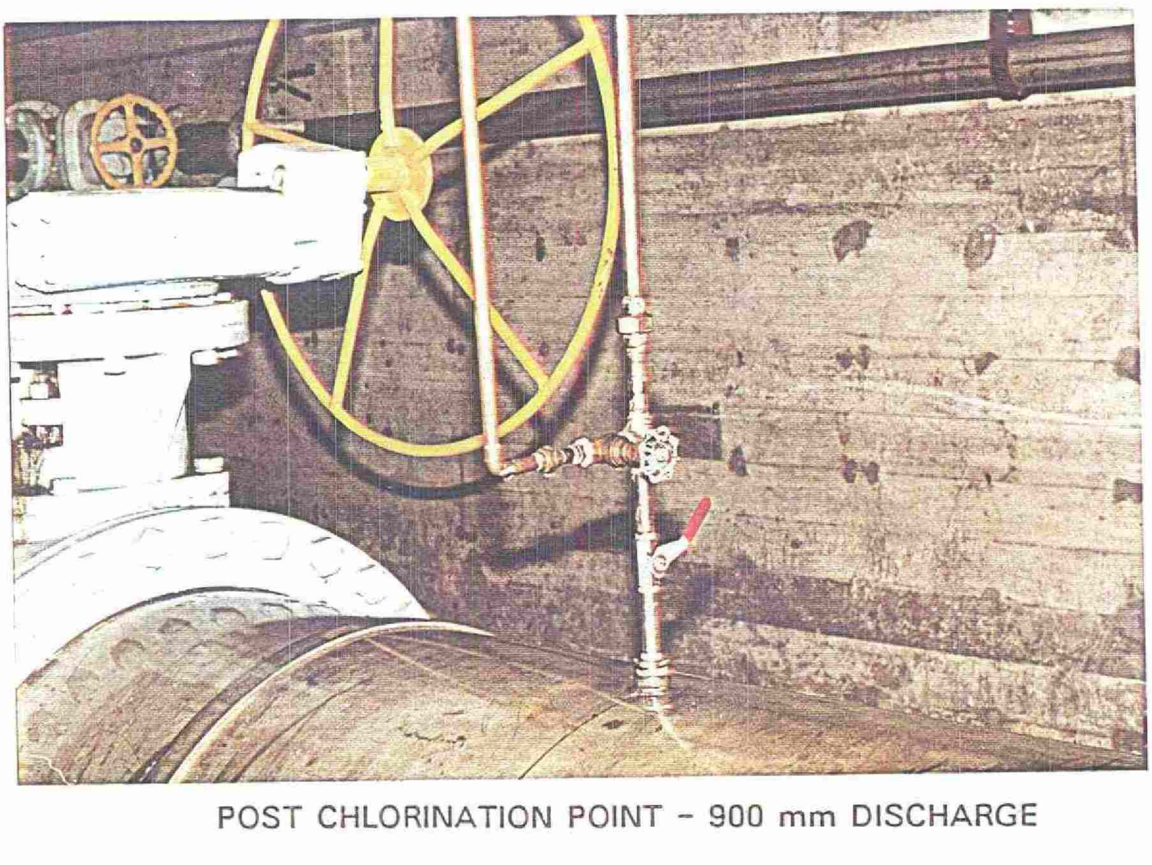


WASH WATER RATE CONTROLLER

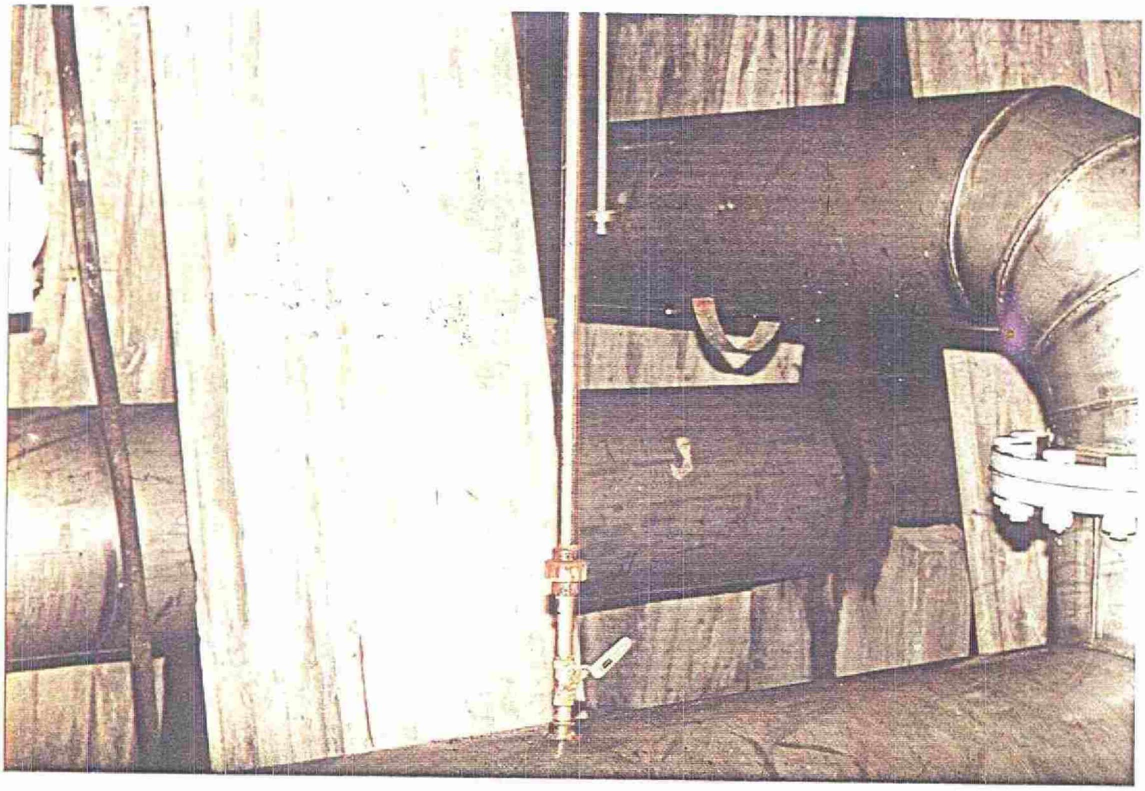


WASH WATER FLOW METER

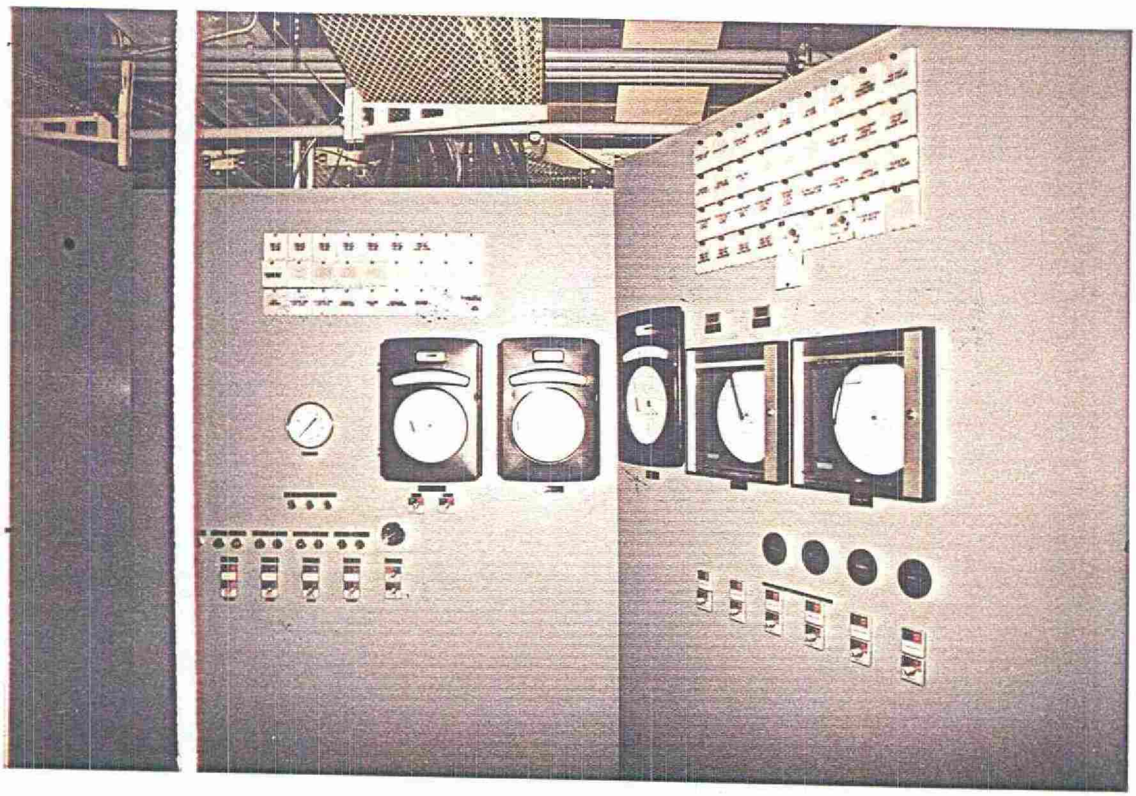
HIGH LIFT PUMPING STATION



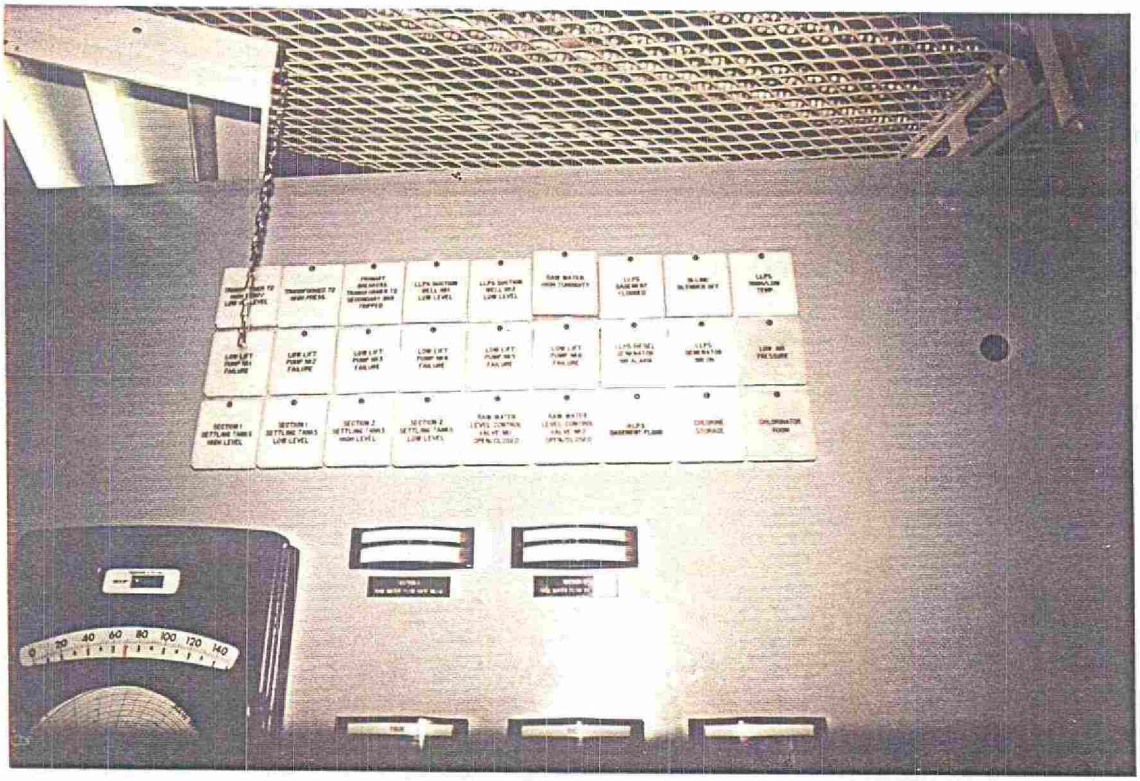
POST CHLORINATION POINT - 900 mm DISCHARGE



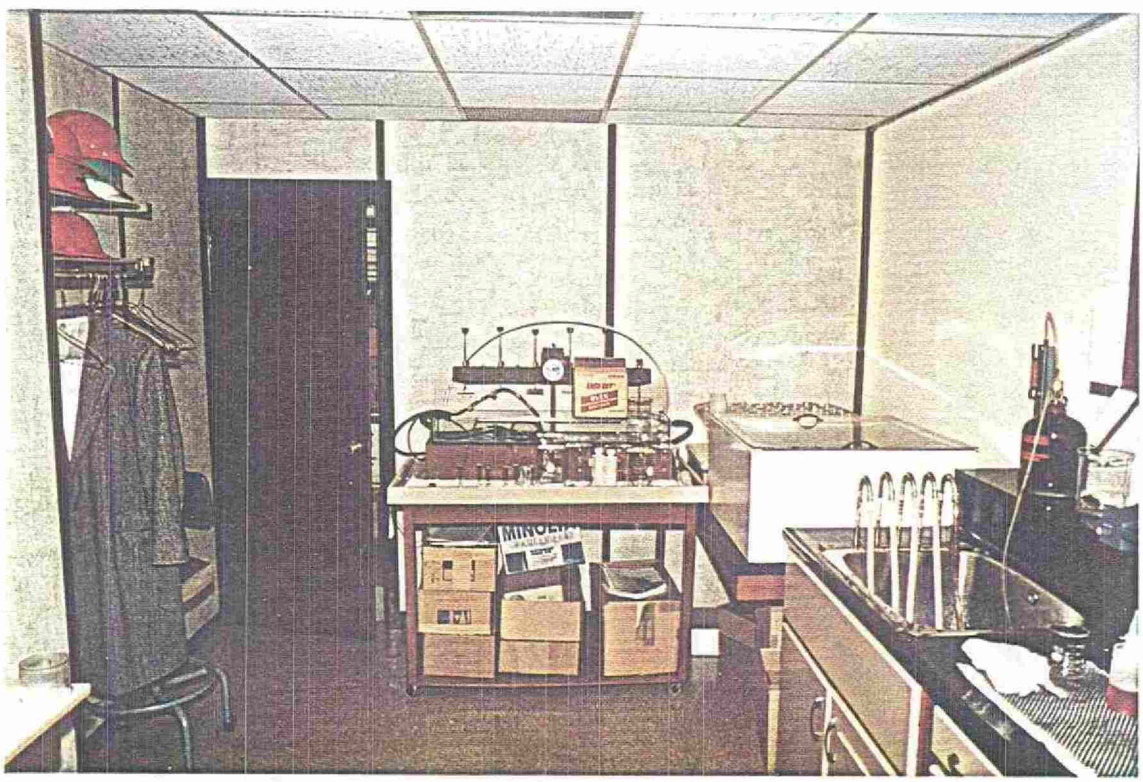
POST-CHLORINATION POINT - 750 mm DISCHARGE



OPERATOR'S CONTROL/INDICATOR PANEL



ALARM LIGHTS - OPERATOR'S CONTROL PANEL



JAR TEST APPARATUS


SAMPLE LINES AND SINK


LAB TURBIDITY METER - HACH 2100A

SECTION D

PLANT OPERATION

SECTION D
PLANT OPERATION

D.1 Description

(a) General

The original 1930 plant has four filters, and the 1954 expansion added another eight filters. The filters and the plant are divided into Section 1 and Section 2.

The plant is in the middle of a contract to install a computerized plant operating system that will include a process control system for the plant and distribution system, and on-line status reporting. This system is expected to be operational in 1987.

(b) Flow Control

RAW WATER

Each section of the plant is fed with raw water via an individual modulating raw water control valve. The two modulating raw water control valves adjust flow to maintain settled water levels within a narrow 150 mm band.

PRE-TREATMENT AND SEDIMENTATION

All the flocculation and sedimentation tanks are used all of the time, except during the twice a year cleaning of the tanks.

Region staff are concerned about closing and opening the inlet isolation valves on the flocculation tanks. Due to the age of these devices, a malfunction may result in significant maintenance and/or downtime. Consequently, the pre-treatment section of the plant is not operated as incremental sections dependent on the flow rate. The implications of this action are discussed in Section E.

(b) Flow Control (cont'd)

FILTRATION

All filters are not operated at all times; there is a rotation system used for the operation of the filters. The flow rate for each filter is set near the maximum. The number of filters operated is dictated by the clearwell demand.

The maximum filter rates are individually set at each filter table. The filter rates are adjusted by a clearwell level override system. As the on-site clearwell approaches a full condition, the clearwell level override system causes the filter rates to decrease. Conversely, a dropping water level in the clearwell causes the filter rates to increase up to the set point on the individual filter rate setters.

(c) Filter Backwashing

The criteria used to initiate a filter backwash is time, headloss, or turbidity. Filters are normally washed on time, at the end of a 72-hour run. The limit for headloss is 2.0 m and turbidity is 1.0 NTU. A copy of the backwashing procedure followed at the Niagara Falls Plant is included in Appendix B.

The low and high wash rates of 14 and 47 m/h, provide a bed expansion of approximately 0% and 30%, respectively, at 15°C. As noted earlier, the volume of water used during a backwash is 5.7 to 7.6 m^3/m^2. Our experience indicates that a wash volume of 4.0 - 5.0 m^3/m^2 should properly clean a filter bed.

The backwash procedure located in Appendix B does not indicate any time or criteria for the duration of the low and high backwash rates. We believe the backwash procedure should be investigated to determine the relative durations of the low and high wash rates so as to minimize the resultant backwash water volume. The backwash must continue to maintain the long term cleaning of the filters.

(c) Filter Backwashing (cont'd)

The Region reports that each filter is rested after a backwash for a minimum period of 15 - 20 minutes before the filter is brought into operation. The filters are brought into operation in a ramp-like fashion to prevent considerable immediate stress on the filter.

Each group of filters is monitored by a turbidity station using a Hach 1720B. Any one of the 4 double filters (8 sample locations) in Section 1 can be monitored at the Section 1 turbidity station by opening the appropriate solenoid valve. A similar turbidity station serves the eight filters (8 sample locations) in Section 2.

A new computer system will monitor the filters in each Section of the plant. The computer system is presently being installed and is expected to be operational in the fall of 1987. At present, this turbidity system is not used to monitor plant performance.

Normal plant operating practice is to monitor the effluent turbidity on the longest running filter in Section 1 and Section 2, respectively, with grab samples taken every four hours. The turbidity of the samples is measured by the laboratory turbidimeter.

(d) Chemical Dosage Control

Alum and chlorine are added year round, and powdered activated carbon is added seasonally when required to combat taste and odour problems.

ALUM

Dosages vary between 5 and 25 mg/L, with a yearly average of 9 to 10 mg/L.

Raw water quality changes are gradual and relatively small; therefore, the corresponding alum dosage adjustments are also small. A turbidity profile, with measurements of raw, settled, filtered, and treated water, are taken and recorded once every four hours. In this way, a change in raw water turbidity and a corresponding change in settled water turbidity can be recognized and dealt with by a change in alum dosage before significant effects are felt by the filters.

Jar tests are carried out on an as-required basis but are not needed as part of the daily operating routine since extensive experience has been accumulated on how to treat the water. If unusual treatment conditions are encountered, a jar test is performed to assess chemical dosages.

The alum metering pump stroke adjustment for dosage is presently manually set, and the pump speed is flow paced. Daily alum usage is determined by measuring level drop in the 35,350 L bulk storage tank. Regional staff recognize that measuring large storage tanks may not be reliable but are confident of the results over a 24 hour period since the level ranges from about 5 to 15 cm/day.

CHLORINE

The Region adjusts the pre-chlorine feeds to maintain a free chlorine residual of 0.2 mg/l on the effluent of the longest running filter. The post-chlorine dosage is adjusted to maintain a free chlorine residual of 0.25 to 0.35 mg/l after the high lift pumps.

Pre- and post-chlorine feeds are taken from the same cylinder. Chlorine residuals are measured by amperometric titration.

Free chlorine residuals are measured at two filter effluent locations, the effluents of the longest running filter in each of the two sections of the plant. The residuals are measured once every four hours.

(d) Chemical Dosage Control (cont'd)

The Region reports that they apply a sufficient chlorine dosage at the exit of the sedimentation tanks so that it tends to keep the filters clean.

The post-chlorination total and free chlorine residuals are measured after the high lift pumps, once every four hours. The combined chlorine is calculated from these measured values. The new computer system will monitor the free chlorine residuals at all filters and the total chlorine residual for the plant effluent.

Daily confirmation of total chlorine used is by weight loss from the active cylinder every 8 hours. The split between pre- and post- can only be determined by the ratio of the set points.

<u>POWDERED ACTIVATED CARBON</u>

PAC is used seasonally to reduce taste and odour problems that occur during July and August. The present system has a capacity of 785 kg/d. At the nominal capacity (146 ML/d) of the plant, this system is capable of 5.4 mg/L of carbon; however, at the 1986 summer flows of 70 ML/d, the carbon system could feed up to 11.2 mg/L.

Over the past three years, the applied carbon dosage has ranged between 1 and 4.6 mg/L. The Region adds carbon during the four summer months of June through to September. It seems that the Region has had very few taste and odour problems for the last two years.

(e) Quality Control Testing

The following table lists pertinent information on the sample systems in use at the Niagara Falls plant. All sample lines listed below terminate in the plant laboratory.

SOURCE	LENGTH/SIZE (m/mm)	FLOW (L/min.)		VELOCITY (m/s)		TRAVEL TIME (min.)	
		Max.	Norm.	Max.	Norm.	Min.	Norm.
Raw Water (screen well)	62/12.7	5.6	5.6	0.67	0.67	1.55	1.55
Treated (750 mm)	32/12.7	46.2*	4.3	6.1	0.57	0.09	0.94
Treated (900 mm) (1)	43/12.7	43.2*	No Flow	5.7	No Flow	0.13	No Flow
Settled (Section 1)	14/10.2	2.6	2.6	0.53	0.53	0.44	0.44
Settled (Section 2)	44/10.2	2.3	2.3	0.46	0.46	1.60	1.60

NOTE: All sample lines are stainless steel. * Based on Regional Tests.

The sample flow rate for each source was determined by a time-displacement test carried out, firstly, at the normal flow rate in use, and secondly, by measuring the flow rate after opening the sample tap to obtain the maximum flow. These tests were conducted in January 1987.

The Region is aware of sedimentation problems in the post-sedimentation sampling lines, and will attempt to improve the situation.

(1) The treated water sample line from the 900 mm diameter high lift discharge header was turned off on the day that the flow test was done.

(e) Quality Control Testing (cont'd)

IN-PLANT MONITORING

The following table gives a list of the tests performed at the plant:

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT
Cl_2 Residual:	Filter effluent of longest running filter in each			(Calibrated monthly)
Free	Section of plant (2)	1/4 hours	1/4 hours	W & T titrator
Total	High Lift Pumps	1/4 hours	1/4 hours	W & T titrator
Turbidity	Raw (screen well)(3)	1/4 hours	1/4 hours	HACH 2100A (Calibrated each use)
	Settled - measured on each Section of plant (3)	1/4 hours	1/4 hours	HACH 2100A
	Filter effluent of longest running filter in each Section of plant	1/4 hours	1/4 hours	HACH 2100A
	Finished (3)	1/4 hours	1/4 hours	HACH 2100A
Temperature	Low Lift Discharge	Once/day	Once/day	Germanow-Simon 300 mm insert Dial Thermometer, 0-50°C. (Calibrated each year)
T.O.N.	Raw	(1) 2-3/week	2-3/week	5 person panel
	Settled	2-3/week	2-3/week	5 person panel
	Finished	2-3/week	2-3/week	5 person panel
	Aged Finished (24 hours)	2-3/week	2-3/week	5 person panel

(1) T.O.N. testing is usually carried out in July and August only.
(2) Filter effluent sample lines terminate at either the Section 1 or Section 2 Turbidity and Chlorine Residual monitoring station in the filter pipe gallery.
(3) Raw, Settled Section 1, Settled Section 2, Treated 750 mm and Treated 900 mm sample lines all terminate in the plant laboratory.

(e) Quality Control Testing (cont'd)

In addition to the above testing there are several instruments in place in the Niagara Falls plant which can continuously monitor:

- Raw Water turbidity
- Filter effluent turbidity and chlorine residual (for the filters in each section)
- Finished water turbidity and chlorine residual in the 750 mm or the 900 mm high lift discharge lines

It is intended that these instruments be used in the near future for automated data collection and process control. To date, however, this system is not fully operational.

D.2 Operation and Process Concerns

(a) In-line Mixer

Recent in-plant tests with a Streaming Current Monitor (SCM) indicated a negative effect on floc development while using the in-line mixer. Although other factors including process considerations prevailed, the end result is that the mixer has been turned off.

(b) Powdered Activated Carbon

The common storage and feed room is small and awkward. There is no direct access from the PAC storage/feed room to outside the building. For convenience, the size and location of the storage and feed facilities should be reviewed.

The feed system capacity is capable of 785 kg/d or 5.4 mg/L at a plant flow of 146 ML/d. This small amount of PAC does not allow plant staff much flexibility in dealing with taste and odour events, although in recent years the taste and odour problems have been minimal.

(b) Powdered Activated Carbon (cont'd)

When PAC is used, carbon carries through the floc and settling tanks and into the filters. At the relatively low PAC dosages in use to date, this carry over of carbon into the filters has not posed an operating problem. However, it is felt that the carbon carry over might pose a problem if the carbon dose is significantly increased.

The permanent PAC application line to the channel between the screens and the low lift well is plugged and a temporary connection into the low lift suction well was used last season.

(c) Flocculation Mixing

The type of mixing provided at the plant is dependent on the flow rate to control the level of mixing. The present operating policy is not to isolate sections of the flocculation tanks to maintain higher flow rates through the remaining sections. The details of this condition are discussed later in Section E.

(d) Settling Tank Leakage

The March 1983 MOE Water Plant Study identified significant leakage from the Section 1 (1930) settling tank clean out valves. It has been reported that leakage from these tanks has been somewhat reduced during other plant modification projects.

Waste treatment of settling tank sludges or filter backwash water is not presently required at the Niagara Falls Water Treatment Plant. If waste treatment should become a requirement in the future, the exact amount of leakage from settling tanks and filters will become more important.

(e) Settling Tanks Short-Circuiting

Short-circuiting in the settling tanks was identified in a MOE Water Plant Study by R. Hunsinger, G. Martin and G. Luck dated March 1983. Short circuiting always occurs in horizontal cross flow tanks. The extent of this short circuiting depends on tank dimensions, inlet and outlet conditions, density currents and overflow rates. This topic is considered in Section E.

For the absolute optimization of the settling tanks at the Niagara Falls WTP, the short-circuiting may have to be addressed.

(f) Powdered Activated Carbon

The PAC feed system is limited to 5.4 mg/L at the nominal plant capacity of 146 ML/d; whereas, a 1982 report by Gore & Storrie showed that dosages of 10-14 mg/L were required to eliminate taste and odour from the water. The report further recommended, subject to further investigation, that the PAC feed system be upgraded to handle increased dosages of perhaps as high as 40 mg/L; however, in recent years, the problems seem to have reduced.

(g) Filters

The plant production rate is usually controlled by the clearwell level which in turn directly modulates the filter flow rates. Thus, in essence, the filters must follow the demand for water from the clearwell; which are the backwash and high lift flow rates. Variable filtration rates are stressful and can lead to reduced performance in filter operation.

The number of filters operated at any time is also dictated by the clearwell demand. Given that the filters have the highest performance at the lowest filtration rates, this policy should be reconsidered. It should however be recognized that there are operational difficulties which arise in operating all filters all the time.

SECTION E

PLANT PERFORMANCE (PARTICULATE REMOVAL)

SECTION E

PLANT PERFORMANCE (PARTICULATE REMOVAL)

E.1 Turbidity Removal

(a) General

The Niagara Falls plant must deal with the raw water quality conditions as shown:

Turbidity (FTU)	0.45 - 51
Colour (TCU)	2.5 - 9.5
Temperature (°C)	0.5 - 26
Alkalinity (mg/L)	95 - 105
Hardness (mg/L)	116 - 132
pH	8.1 - 8.4
Aluminum (mg/L)	0.009 - 0.380
Iron (mg/L)	0.04 - 0.34
Manganese (mg/L)	0.009
Threshold Odour (TON)	0 - 2

November, December, January and February are the months that generally experience high raw water turbidities. The table below shows the range of turbidity conditions for the poor raw water period.

1983 - 1986	RAW TURBIDITY (FTU)		
	Max.	Min.	Avg.
November	19	0.9	4.2
December	51	2.2	13.7
January	42	2.3	8.8
February	17	1.9	4.2

A review of the above table shows that the average turbidity in December is 13.7 FTU and that December is the worst month of the winter period.

(a) General (cont'd)

The remaining period of the year, March through October, generally experiences lower turbidities as shown below:

1983 - 1986	RAW TURBIDITY (FTU)		
	Max.	Min.	Avg.
March	15	1.3	2.9
April	14	0.9	4.3
May	15	0.8	3.0
June	12.5	0.7	1.9
July	16	0.48	1.4
August	8.4	0.45	1.35
September	1.0	0.5	1.6
October	14	0.47	1.8

With the exception of December and January, the balance of the year experienced average turbidities of less than 5 FTU.

A graph is included in Appendix C as Figure 1.0 showing a Composite Profile of Raw Water Turbidity Ranges for the 1983 - 1986 period.

(b) Plant Performance

OVERALL PLANT PERFORMANCE

It is usual to consider two conditions for plant operation, the maximum hydraulic flow rate and the maximum process flow rate. The maximum process condition, from the stand point of particulate removal, occurs with the highest solids loading on the plant. The maximum flow and worst raw water quality are not coincident at this plant, as shown above. The flow in any year only varies about 3:1, while the raw water solids and corresponding solids generated within the process can vary about 50:1; therefore the maximum process condition corresponds to the worst water quality condition.

The plant records for treated water during the poor raw period can be summarized as follows:

(b) Plant Performance (cont'd)

1983 - 1986	TREATED TURBIDITY (FTU)		
	Max.	Min.	Avg.
November	0.95	0.06	0.22
December	0.70	0.10	0.27
January	0.88	0.11	0.26
February	1.3	0.09	0.30

Treated water records for the remaining period of the year are summarized below:

1983 - 1986	TREATED TURBIDITY (FTU)		
	Max.	Min.	Avg.
March	0.93	0.10	0.31
April	1.3	0.11	0.37
May	1.6	0.09	0.34
June	0.81	0.06	0.34
July	0.93	0.09	0.32
August	0.64	0.10	0.28
September	0.75	0.11	0.26
October	0.65	0.07	0.24

A graph is included in Appendix C as Figure 1.1 showing a Composite Performance Profile of Treated Water Turbidity Ranges for the period 1983 - 1986. Within this period, there were three months, February, April and May, when the treated water turbidities climbed above 1.0 FTU. Actually, there were only 4 days when the treated water turbidity climbed above 1.0 FTU. The four events were:

	Max. Treated Turbidity (FTU)
23 February 1985	1.3
7 April 1984	1.3
2 May 1984	1.6
3 May 1984	1.3

(b) Plant Performance (cont'd)

All events where turbidities exceeded 1.0 FTU occurred after periods of rising raw water turbidity. However, at other periods of the year, such as during December when the worst raw water conditions exist, there were no occasions when the treated water turbidity rose above 1.0 FTU.

ASSESSMENT OF OVERALL PERFORMANCE

The turbidity guideline in the Province of Ontario is 1.0 FTU; but clearly it is important to reduce the turbidity to as low a level as is practical.

The historic records of the plant have been reviewed as a means to assess plant performance under various operating conditions.

Performance Profile Tables 2.1, 2.2, 2.3, 2.4 and 2.5 for the months of December 1985, January 1986, February 1984, April 1984 and May 1984 are included in Appendix A. Performance Profile Graphs are included in Appendix C as Figures 2.1, 2.2, 2.3, 2.4 and 2.5 for the same months as listed above.

After studying the specific events where the turbidities exceeded 1.0 FTU as discussed above, it appears that the time lag involved in making alum dosage adjustments to meet changing raw water conditions resulted in the increased treated water turbidities.

E.2 Treatability Testing

(a) Jar Testing

TURBIDITY REMOVAL

Treatability testing was carried out on a raw water sample collected on 6 November 1986. This raw water sample had a turbidity of 1.2 NTU. The Laboratory and Treatability results sheets are included in Appendix D.

(a) Jar Testing (cont'd)

Alum was used in the coagulation/flocculation/sedimentation testing, followed by filtration through a 1.2 µm membrane which, in our experience, emulates the performance of a dual media filter. The results of the testing demonstrate that filtration down to a turbidity of <0.2 NTU is achievable with an appropriate alum dosage.

An MOE report entitled "Niagara Falls - Water Treatment Plant Study", dated March 1983 by R.B. Hunsinger, G.W. Martin and G. Luck, carried out laboratory tests with much higher raw water turbidity, and obtained filter effluent turbidities ranging from 0.15 to 0.17 NTU with alum and alum plus polyelectrolytes. The MOE have recently carried out tests which provide similar results.

It is our opinion that additional testing should be carried out by the plant staff to ascertain the relative merits of specific polyelectrolytes to reduce the filter effluent turbidities. Clearly, the improved performance must be gauged against the increased costs of operation.

ALUMINUM RESIDUAL

Aluminum solubility in water is a complex topic; but some of the most significant variables are pH, time and temperature. For pH values greater than 6.5, the aluminum residual increases directly with pH. Aluminum residual is inversely proportional to time, up to several hours, whereupon the solubility concentration remains fairly constant. The aluminum residual is directly related to temperature, but this has a fairly minor impact over the ranges encountered in natural waters. For times greater than an hour and pH's greater than about 7.4, water will contain a residual concentration greater than 0.1 mg/L.

For the aluminum residuals and pH values found in the waters at the plant, the results are consistent with general experimentally determined values. Therefore, it is not surprising to find aluminum concentrations greater than 0.1 mg/L.

(a) Jar Testing (cont'd)

Niagara Falls' treated water aluminum residuals have sometimes been above the guideline of 0.1 mg/L, therefore, jar tests were run to check aluminum residual. In our opinion, the benefits associated with changing the alum dosage to control the aluminum residual, over and above those for turbidity control, is not warranted.

COAGULANT(S) DOSAGE

From the test work which has been done by the Region and ourselves, the appropriate alum dosage to achieve an optimum filter effluent quality for the raw water samples tested is about 10 mg/L.

(b) Streaming Current Monitor

It was stated earlier that, during periods of rapidly changing raw water turbidity, the alum dosage changes lagged changes in the turbidity. A streaming current monitor (SCM) may allow both a faster response and the selection of the correct coagulant dosages.

E.3 Optimum Removal Strategies

(a) Flocculation Mixing and Sedimentation

As noted in previous sections, all the flocculation and sedimentation tanks are used at most times. There exists a concern about the possible malfunctioning of the isolation valves on the flocculation tanks. Since the level of mixing in the flocculation tanks is dictated by the flow rate, there may be some benefits obtained from isolating the pretreatment sections of the plant. The resident time afforded by having all tanks operational is increased at lower flows; thus the mixing system tends to compensate for the reduced flow rates. In addition, the settling tank performance is inversely dependent on the flow rate; therefore, this unit operation tends to also compensate for reduced mixing levels at lower flow rates by becoming more efficient. Clearly, there are bounds to how low the flow rate can be before overall performance is effected, but this should not be experienced at this plant.

(a) Flocculation Mixing and Sedimentation (cont'd)

It is our opinion that there is merit to investigating, on a plant scale, the magnitude of improvement which would result from maintaining high flows in the flocculation tanks. From an operational stand point, however, we believe that the performance improvements may only be small and not worth the efforts of opening and closing valves to suit the changing flows. Therefore, the most benefit may arise from a better understanding of the plant unit operations.

(b) Filtration

The number of filters and the filtration rates are presently dictated by the demand for clearwell water. This procedure is stressful for the filters since any change of flow rate can reduce filter removal performance. Also, the lower the filtration rate, the better the removal performance; which can be achieved by operating all filters all the time. Therefore, from the standpoint of particulate removal, the ideal procedure would be to operate all filters with a constant flow rate to satisfy some long-term demand. This procedure requires that the clearwell level rise and fall to offset the difference between production and demand flow rates. From an operational standpoint, however, this strategy should review the benefits against the associated costs.

It is our opinion that tests should be carried out on plant scale to determine the magnitude of improvement which would result from maintaining lower constant flow rates. These results should be assessed in light of the operational considerations.

SECTION F

PLANT PERFORMANCE (DISINFECTION)

SECTION F
PLANT PERFORMANCE (DISINFECTION)

F.1 Disinfection

At the Niagara Falls Water Treatment Plant, disinfection is practiced by pre-chlorination between the settling tanks and filters, and post-chlorination after the clearwells. The average total chlorine dose is about 1.1 mg/L, with pre-chlorination using about 70% of this amount. Data shown in Tables 3.0 and 3.1 in Appendix A show that the total monthly average chlorine dosage ranged from 0.75 to 1.85 mg/L.

The Region does not routinely conduct chlorine demand tests on the water. As discussed earlier, the Region adjusts the pre-chlorine dosage to maintain a 0.2 mg/L free chlorine residual in the effluent of the longest running filter, and adjusts the post-chlorine dosage to maintain a free chlorine residual of 0.25 to 0.35 mg/L in the plant effluent.

F.2 Disinfection Efficiency

Tables 7.0 to 7.3 in Appendix A summarize the available raw and treated microbiological data for the Niagara Falls plant.

Fecal coliforms, as well as total coliforms, were found in the raw water.

The data show that the microbiological quality of the treated water leaving the plant is good. Total coliforms were detected in the treated water on three occasions during 1983 to 1986. Two results showed one count per 100 mL, and one result showed two counts per 100 mL. This meets the Ontario Drinking Water Objective of less than five counts per 100 mL.

In our opinion, the chlorine feed system and the operations policy for disinfection of the water are adequate. A separate method of weighing pre- and post-chlorine feeds would be a worthwhile modification, since it would permit a direct assessment of the dosages.

F.3 Chlorinated By-Products

TRIHALOMETHANES

Trihalomethanes (THM's) are the most widely occurring organics found in drinking water, and they also appear at the highest concentrations. The principal source of THM's in drinking water is the chemical interaction of chlorine added for disinfection, with humic and fulvic substances that occur naturally in the raw water. There is some evidence that THM's are carcinogenic. The Ontario Drinking Water Objectives for THM's is 350 µg/L.

Based on the data available on THM's (see Table F.1) for the Niagara Falls Water Treatment Plant, the levels of THM's found in treated water are well under the Ontario Drinking Water Objectives of 350 µg/L (0.35 mg/L). Total THM values were determined by the purge and trap method, which, for the treated water, ranged from 25 to 50 µg/L, with an average value of 35 µg/L. Therefore, it is our opinion that little should be done, at this time, to assess methods of reducing the THM's to lower levels.

TOTAL ORGANIC HALIDES

The terms of reference require consideration be given to the reduction of chlorinated by-products in the treated water. There was no complete set of information on the total concentrations of all organohalogen compounds.

It is our opinion that a broader measurement of chlorinated by-products should be considered and possibly a surrogate measurement should be utilized. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum total of all the organic halogen compounds.

TABLE F.1

Trihalomethane Data for Niagara Falls WTP

		1984		1985		1986	
		R	T	R	T	R	T
JAN	Chloroform, µg/L ($CHCl_3$)						14
FEB							12
MAR							18
APR							10
MAY							17
JUN							15
JUL							16
AUG							
SEP							
OCT					20		
NOV							
DEC							
JAN	Bromodichloromethane, µg/L ($CHBrCl_2$)						11
FEB							9
MAR							11
APR							8
MAY							11
JUN							10
JUL							9
AUG							
SEP							
OCT					14		
NOV							
DEC							
JAN	Chlorodibromomethane, µg/L ($CHBr_2Cl$)						13
FEB							11
MAR							13
APR							7
MAY							5
JUN							5
JUL							5
AUG							
SEP							
OCT					16		
NOV							
DEC							
JAN	Bromoform, µg/L ($CHBr_3$)						
FEB							
MAR							
APR							2
MAY							
JUN							
JUL							
AUG							
SEP							
OCT							
NOV							
DEC							

TABLE F.1 (cont'd.)

		1984		1985		1986	
		R	T	R	T	R	T
JAN	Total THM's, µg/L						38
FEB							32
MAR							42
APR							25
MAY							33
JUN							30
JUL							30
AUG							
SEP							
OCT					50		
NOV							
DEC							
AVG.	Total THM's, µg/L						33
RNG.	Total THM's, µg/L						25-38

R = Raw water
T = Treated water
D = Distributed water

SECTION G

SHORT AND LONG-TERM MODIFICATIONS

SECTION G

SHORT AND LONG-TERM MODIFICATIONS

G.1 Description

(a) General

This section includes feasible short and long-term process modifications required to approach optimum disinfection and particulate removal. It is important to understand that optimization of selected process steps may be in conflict with other aspects of the plant, such as staffing and budgeting costs. Estimated costs for each recommendation are also included.

The following short and long-term recommendations were provided, discussed, reviewed, and agreed upon at the plant site meeting.

We have assigned costs for each of the recommended works. Clearly, these costs may be reduced if the Region carries out the work.

G.2 Raw Water Flow Metering

The raw water flows of Sections 1 and 2 are metered separately, but the total water flow is recorded on the daily record sheet.

It is recommended that the Section 1 and Section 2 raw water flows be recorded separately.

This item could be incorporated into the SCADA system, which is expected to be operational in the fall of 1987. The cost for this change should be minimal.

G.3 In-Line Mixer

The existing in-line mixer has been shut off because the Region carried out tests with a Streaming Current Monitor (SCM) which showed that the mixer was detrimental. According to MOE design practices, flash mixing is generally considered to be essential to the process.

G.3 In-Line Mixer (cont'd)

Additional testing of the in-line mixer should be conducted to evaluate its effect on floc formation.

It is recommended that detailed laboratory and plant-scale tests be conducted to determine the value of rapid mixing for the various flow and water quality conditions at this plant. The SCM should be installed prior to this investigation as it is an integral part of the evaluation of plant mixing.

The effect of the distance of travel to Section 2 on floc formation and stability should also be examined.

The cost of the work described here would be $10,000 to $15,000.

G.4 Alum Pump Calibration

The ease and accuracy of metering pump calibration and confirmation of actual set dosages is vital to the optimum operation of a coagulant feed system.

Tests should be conducted to assess the changes in calibration; if it is found that the calibration changes quickly, then consideration should be given to the installation of graduated containers on the suction side of each alum metering pump. The pumps should be calibrated regularly against the stroke position. The pumps are presently calibrated every six months.

This recommendation should be implemented immediately on the existing alum pumps and should be included with any future coagulant metering pump installation. The cost to install the graduated containers is about $300 per pump.

G.5 Coagulant Application Point

Alum is applied to the common raw water header before the flow splits to Sections 1 and 2. To optimize the performance of each Section, the alum feed must be applied separately to each section based on their respective flows.

G.5 Coagulant Application Point (cont'd)

It is recommended that separate alum feed systems be installed for Section 1 and Section 2. The merits of dilution of alum prior to its injection into the raw water lines should be assessed on a laboratory scale. The degree of alum dilution should be assessed to avoid clogging in the lines.

In-line mixers would require extensive modifications and could take some time to implement should they be shown to have merit. The cost would be $30,000 to $60,000.

If in-line mixers are not required, and only alum pumps and piping need to be changed, the modifications could be implemented quickly. The cost would be $5,000 to $10,000.

G.6 Coagulant Aids

Following the optimization of alum addition for Sections 1 and 2, the next step is the use of various coagulant aids.

The Region of Niagara has a history of evaluating new coagulants and coagulant aids. It is recommended that the Region continue to perform laboratory studies to pre-screen the various polyelectrolytes available. Previous test results should be reviewed, summarized, and catalogued into one document.

A plant-scale pilot program should be conducted for the various seasons of one year using the preferred polyelectrolytes as coagulant aids.

The coagulant aid testing should be carried out after decisions have been made on the alum feed split, streaming current monitor, and in-line blenders. The cost for equipment to carry out this test work is $30,000, and the chemical cost is $5,000 to $10,000 for a one year test.

G.7 Streaming Current Monitor (SCM)

Accurate and timely adjustments to coagulant feed rates are vital to achieve optimum particulate removal. The present time lag between the alum feed adjustment and the results at the filter inlet is several hours. The purpose of the SCM is to permit a response to changing raw water conditions in a few minutes.

It is recommended that further study be conducted on the merits of SCM's. If this proves successful, install two SCM's; one for Section 1 and one for Section 2, in such a way to allow sufficient time for mixing of coagulants with or without in-line mixers.

The installation of the SCM's should be coincident with dosing alum separately for Sections 1 and 2. The cost would be $20,000 to $30,000.

G.8 Isolation of Flocculation Tanks

Since the level of mixing in the flocculation tanks is proportional to the flow rate, there may be some benefit obtained by shutting off groups of flocculation tanks. The isolation of the flocculation tanks also isolates the associated settling tanks. Presently, there is concern about the possible malfunctioning of the isolation valves and freezing within the tanks. Throttling is an alternative, which would maintain low flows through the sedimentation tanks and solve the problem of icing.

It is recommended that the operation of the flocculation tanks at various flow rates be compared.

This plant-scale work should be carried out during periods when the overall plant flows are lower. The cost of this recommendation is minimal.

Should maintaining high flows in the flocculation tanks provide significant performance improvements, consideration should be given to replacing manual isolation valves with motorized valves for ease and reliable isolation of flocculation sections.

G.9 Flow Pattern in Flocculation Tanks

The present flocculation tanks are over and under hydraulic tanks. Water enters the bottom of the first cell, the top of the second cell, the bottom of the third cell, etc. Test work at other facilities has shown improved performance when all cells have bottom entries.

It is recommended that the flocculation tanks in Section 1 be converted to 'bottom' entry for each cell. This conversion can be done by using corner baffles.

This change should be delayed until after the split alum feed optimization. The cost to retrofit the nine cells of the Section 1 flocculation tanks is $30,000 to $50,000.

G.10 Settling Tank Short-Circuiting

Tracer tests conducted by the MOE (1983) demonstrated short-circuiting in the settling tanks. This is prevalent to some degree in all tanks, but there is merit in assessing the benefits which would result from reducing this condition. As demonstrated by the MOE, the importance of the solids removal efficiency of the settling tank is limited because of the relatively low initial solids loadings. The most important benefit that may arise could be a better understanding of this unit operation.

It is recommended that consideration be given to a study to evaluate the possibility of locating baffles, etc., in the settling tanks so as to minimize the short-circuiting prevalent in these tanks.

This work could be carried out at any time. The cost of such a study would be $5,000 to $10,000.

G.11 Filtration Rates

Filtration rates are presently dictated by the demand for clearwell water. This procedure causes changes of flow rate and can reduce the filters' particulate removal capability.

G.11 Filtration Rates (cont'd)

It is recommended that plant scale tests be carried out on the filters to determine the magnitude of improvement which would result from maintaining lower constant filter flow rates. One aspect to be studied is the lowest filter flow rate that must be maintained for the flow controllers to work.

The plant scale tests could commence immediately and should extend over various seasons. The new SCADA system will record the flow rates through the filters and will allow a study on the setting of filter rates to be properly carried out.

The cost of this work would be minimal since the majority of the data will be readily available to Region staff. An allowance of $5,000 should be made to interpret the information.

G.12 Filter Media Characteristics

The characteristics of filter media can change with time. Media can be lost during backwashing and, in some instances, media can escape through support systems and end up in the clearwell. The anthracite media actually breaks up by mechanical abrasion over a period of time.

It is recommended that the Region continue to carry out sieve analysis and grain size characterization on each filter once every five years. The distance from the filter walkway to the top of the media for each filter should be measured and recorded once every year. This measurement should be carried out at four locations in each filter immediately after placing the filter back on line following a backwash. These records become an early warning of media problems.

The Region has a documented program for conducting sieve analyses, and stores the results on disk. This technology should be transferred to other municipalities.

G.13 Filter Cleaning

Our previous experience has shown that a backwash water volume of 4.0 to 5.0 m^3/m^2 of filter area adequately cleans a filter bed. The wash volume at the Niagara Falls Plant is significantly higher at 5.7 to 7.6 m^3/m^2.

It is recommended that the backwash procedure be investigated to determine the relative durations of the low and high wash rates to minimize the wash volume and yet maintain the long term cleaning of the filter.

This work could be carried out any time. This recommendation should be carried out by Regional staff.

G.14 Backwash Water Records

The quantity of backwash water used to wash each filter is useful information to record in the plant records. This information can assist in identifying problems with a specific filter or in identifying a gradual change with time for all filters.

It is recommended that the quantity of backwash water for every filter wash be recorded.

G.15 Chlorine Use Verification

Pre- and post-chlorine are presently fed from the same cylinder; therefore, it is only possible to verify the total chlorine use by recording weight loss from the single cylinder.

It is recommended that the Region install a separate weigh scale to allow individual weighing of pre- and post-chlorine feeds.

This recommendation would cost about $5,000 for the scale alone.

G.16 Chlorinated By-Products

It is our opinion that a broader measurement of chlorinated by-products should be considered. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum total of all the organic halogen compounds.

It is recommended that the Province of Ontario develop a surrogate for organics.

G.17 Record of Information

The nature, frequency, and arrangement of information recorded about plant operations is vital to the operation and management of a water treatment plant. The Region, through consultation with the staff and trial and error, has developed an excellent daily record system and form.

The Niagara Falls Plant uses the LOTUS spreadsheet format extensively, and the WPOS tables, adapted to the Niagara Falls specifics with two plants operating in one facility, could be stored on this format. We recommend that this information be kept at the plant and continuously updated. A particularly useful set of operating data is the Turbidity Profile through the plant. These records indicate the effects of changing conditions on specific operations through the process.

The Plant's record of information should also include the following:

- Process and piping diagram (PAPD)*
- Filter media characteristics
- Drawings
- Any data to be used in the future for operation of the Plant or design purposes.

* The PAPD is currently being developed by Regional staff, and it is recommended that it be stored on a CADD system for the ease of updating.

G.18 Sample Line Flow Verification

It is recommended that the flow rates to the various sample taps be verified by simultaneous sampling at the source and at the tap. The tests should be conducted during low and high turbidity periods.

This work could be carried out any time. This recommendation should be carried out by Regional staff.

APPENDIX A

TABLES

TABLE 1.0: FLOWS (ML/d)

WPOS NIAGARA FALLS WTP

		1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	R			46.4			50.0			51.5			44.1
	T	46.4	39.9	42.6	54.5	--	45.5	47.8	39.6	44.5	41.0	31.7	35.9
FEB	R			44.7			50.4			48.1			45.8
	T	46.4	40.5	41.9	52.2	41.5	45.8	46.2	41.1	41.1	40.3	24.1	35.8
MAR	R			44.8			48.0			44.4			45.0
	T	45.5	40.2	42.9	50.4	43.1	46.4	42.9	31.0	38.1	41.0	34.2	37.3
APR	R			45.5			50.9			43.6			47.9
	T	51.1	42.2	44.9	48.6	36.8	41.2	44.2	28.4	40.5	45.6	34.3	38.7
MAY	R			58.5			65.7			46.3			49.1
	T	72.1	45.0	52.9	84.6	38.4	54.5	56.6	36.0	43.1	47.3	37.3	41.4
JUN	R			60.6			68.3			67.9			77.4
	T	73.7	50.0	59.6	85.7	44.3	58.7	91.0	45.8	61.7	115.8	46.2	73.6
JUL	R			69.8			85.1			91.5			96.0
	T	(115.7)	46.7	66.2	(110.2)	51.4	76.1	106.7	60.1	83.1	(129.4)	52.5	95.5
AUG	R			64.9			79.9			85.4			65.7
	T	84.7	49.2	61.9	108.6	50.3	71.9	(108.8)	60.4	77.6	91.9	49.7	64.9
SEP	R			57.2			62.2			63.2			58.5
	T	73.4	48.4	55.6	66.0	49.1	55.0	66.7	53.2	59.3	77.7	43.8	56.3
OCT	R			51.6			56.3			56.3			49.3
	T	54.4	46.9	50.4	53.0	44.2	48.0	61.5	41.6	51.7	52.0	39.2	45.3
NOV	R			47.6			51.2			46.4			--
	T	51.3	42.9	46.5	47.3	39.6	43.0	53.9	36.6	42.2	54.3	32.8	43.2
DEC	R			45.0			46.1			48.1			--
	T	46.6	37.8	43.0	44.8	37.7	42.0	47.1	33.9	43.7	45.7	34.6	42.4

NOTE: Flows are measured using venturi meters which are calibrated twice a year.
[redacted] Br[redacted]ts [redacted]cat[redacted]. d[redacted]for [redacted]yea[redacted]

TABLE 1.1: PER CAPITAL CONSUMPTION (L/DAY/CAPITA)

WPOS NIAGARA FALLS WTP

	1986	1985	1984	1983
POP.(1)	68,700	69,043	68,843	68,843
MAX.	1684	1596	1580	1880
MIN.	550	546	413	350
AVG.	738	758	758	739
MD/AD	2.28	2.11	2.08	2.54

MD/AD = Maximum Day/Average Day

(1) These data were provided by the Regional planning group via the WTP staff.

TABLE 2.0: PARTICULATE REMOVAL SUMMARY

WPOS NIAGARA FALLS WTP

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	Turbidity (FTU)		R	42.0	3.5	11.7	27.0	4.4	10.8	12.5	2.3	5.25	20.0	2.8	7.6
			T	0.76	0.12	0.26	0.64	0.11	0.21	0.54	0.11	0.26	0.88	0.14	0.33
	Alum	(mg/L)		22.3	13.5	18.2	13.2	10.7	12.1	17.8	6.2	11.0	25.3	13.4	16.6
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.280									
			T			0.042									
	pH		R			8.1			8.1			8.3			8.2
			T			7.5			7.5			7.9			8.0
	Temperature	(^{o}C)		0.7	0.5	0.5	4.5	0.5	1.7	8.5	1.0	5.4	14.0	3.0	8.1
FEB	Turbidity (FTU)		R	9.5	1.7	3.6	17.0	2.3	4.4	8.6	1.9	3.3	17.0	2.1	5.3
			T	0.43	0.12	0.24	1.3	0.09	0.21	1.0	0.24	0.45	0.65	0.14	0.3
	Alum	(mg/L)		15.9	10.7	11.9	16.6	9.3	12.2	13.5	5.2	7.4	26.0	10.5	17.9
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.110									
			T			0.046									
	pH		R			7.6			8.1			8.2			8.2
			T			7.4			7.6			7.9			7.8
	Temperature	(^{o}C)		0.7	0.5	0.6	1.0	0.5	0.6	9.0	2.0	5.4	8.5	1.0	5.2
MAR	Turbidity (FTU)		R	15.0	1.5	3.2	10.0	1.4	3.0	6.4	1.4	2.8	7.6	1.3	2.8
			T	0.51	0.11	0.27	0.55	0.10	0.18	0.93	0.16	0.46	0.64	0.17	0.31
	Alum	(mg/L)		14.5	9.0	12.0	11.9	9.5	10.4	13.4	6.0	10.8	21.4	10.2	15.5
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R	0.380	0.170	0.28									
			T	0.065	0.073	0.07									
	pH		R			8.0			8.2			8.2			8.0
			T			7.6			7.7			7.7			7.6
	Temperature	(^{o}C)		1.5	0.5	0.7	1.0	0.5	0.8	6.0	0.5	3.3	9.0	1.0	5.8

Note: Raw and finished water turbidities are measured every 4 hours using a HACH 2100A turbidity meter. Alum dosage is recorded every 8 hours. Temperature is measured with an inline temperature probe and recorded daily. pH is measured monthly at the MOE lab, Resources Road, Rexdale. Aluminum residual is tested for monthly under DWSP. Water samples for turbidity readings and DWSP testing are obtained from sample taps in the plant lab.

TABLE 2.0 (cont'd.)

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
APR	Turbidity (FTU)		R	9.8	1.0	3.0	14.0	1.7	9.6	14.0	1.2	2.7	3.5	0.98	1.8
			T	0.55	0.13	0.37	0.63	0.11	0.24	1.3	0.16	0.48	0.70	0.21	0.37
	Alum	(mg/L)		17.9	8.9	13.3	18.4	6.7	13.7	24.4	10.1	11.2	24.8	11.5	15.8
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.011									
			T			0.130									
	pH		R			8.3			7.2			8.4			8.2
			T			7.9			7.7			7.8			7.7
	Temperature	(°C)		4.5	0.6	1.5	2.3	0.5	1.0	5.5	0.5	2.9	13.0	3.0	9.6
MAY	Turbidity (FTU)		R	14.0	1.1	3.5	13.0	0.85	2.4	15.0	0.8	4.1	9.2	1.0	2.1
			T	0.61	0.09	0.23	0.53	0.12	0.22	1.60	0.15	0.48	0.85	0.24	0.42
	Alum	(mg/L)		22.1	9.2	12.5	15.4	9.2	11.7	22.6	5.2	15.2	15.8	5.7	12.8
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.059									
			T			0.120									
	pH		R			8.3			8.3			8.1			8.1
			T			7.9			7.7			7.9			7.7
	Temperature	(°C)		14.5	5.0	9.4	12.5	2.3	8.1	11.3	4.5	8.1	15.0	8.0	11.1
JUN	Turbidity (FTU)		R	6.8	1.1	2.1	10.0	0.92	2.2	12.5	0.9	1.9	3.4	0.72	1.3
			T	0.66	0.13	0.27	0.51	0.14	0.24	0.81	0.06	0.42	0.73	0.24	0.43
	Alum	(mg/L)		16.9	8.5	11.9	13.5	10.2	11.3	19.9	9.0	12.4	16.9	10.2	12.8
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.009									
			T			0.046									
	pH		R			8.2			8.3			8.0			8.2
			T			8.0			7.8			7.7			7.6
	Temperature	(°C)		18.7	12.9	15.6	17.5	13.0	15.3	19.3	11.5	15.8	20.0	13.0	16.3

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	Turbidity (FTU)		R	4.0	1.0	1.6	16.0	0.8	1.6	3.9	0.8	1.5	1.25	0.48	0.85
			T	0.56	0.11	0.27	0.61	0.09	0.26	0.60	0.13	0.34	0.93	0.17	0.39
	Alum	(mg/L)		12.0	5.5	8.8	13.3	9.5	12.0	11.8	7.0	9.0	13.6	4.6	8.9
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.033									0.020
			T			0.310									0.770
	pH		R			8.4			8.3			8.2			8.4
			T			8.0			7.8			7.7			7.9
	Temperature	(^oC)		23.6	18.5	20.4	22.3	17.2	20.4	23.0	19.0	21.1	25.0	20.0	23.1
AUG	Turbidity (FTU)		R	8.4	1.0	2.7	2.7	0.6	1.0	1.8	0.54	0.90	1.8	0.45	0.80
			T	0.5	0.15	0.24	0.50	0.10	0.19	0.64	0.20	0.41	0.62	0.13	0.26
	Alum	(mg/L)		14.2	7.3	9.1	15.9	5.9	10.6	10.4	5.6	7.4	15.8	6.4	10.4
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R			0.083									
			T			0.310									
	pH		R			8.4			7.8			8.6			8.5
			T			8.1			7.8			8.0			8.0
	Temperature	(^oC)		23.6	20.2	22.7	23.0	21.5	22.2	29.0	22.0	23.3	26.0	23.0	24.4
SEP	Turbidity (FTU)		R	10.0	1.2	2.8	2.2	0.9	1.3	9.8	0.5	0.94	2.8	0.5	1.3
			T	0.75	0.11	0.22	0.55	0.15	0.26	0.53	0.23	0.32	0.42	0.15	0.24
	Alum	(mg/L)		16.1	6.2	9.2	20.3	5.3	9.4	8.8	5.9	7.2	13.2	8.9	9.9
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R												
			T												
	pH		R			8.2			8.3			8.5			8.4
			T			8.3			7.8			8.0			7.8
	Temperature	(^oC)		21.0	18.0	19.3	22.5	19.0	20.8	23.0	18.0	20.1	25.0	19.0	22.4

TABLE 2.0 (cont'd.)

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
OCT	Turbidity (FTU)		R	12.0	1.3	3.9	14.0	1.0	3.0	4.7	0.47	0.93	3.8	0.7	1.9
			T	0.44	0.13	0.24	0.41	0.15	0.25	0.65	0.07	0.22	0.43	0.13	0.26
	Alum	(mg/L)		10.8	6.4	8.8	32.2	9.3	12.1	10.1	6.9	8.0	17.1	7.7	10.3
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R												
			T												
	pH		R			8.3			8.4			8.3			8.3
			T			8.3			7.2			7.8			8.0
	Temperature	(^oC)		18.0	13.2	15.1	19.3	13.5	15.9	17.5	14.1	15.8	21.0	15.0	17.7
NOV	Turbidity (FTU)		R	16.0	1.4	4.9	12.0	1.0	4.5	19.0	0.9	4.0	11.0	0.99	3.5
			T	0.50	0.06	0.26	0.95	0.14	0.25	0.64	0.11	0.20	0.34	0.10	0.18
	Alum	(mg/L)		13.7	6.1	9.18	15.2	9.1	12.0	9.4	6.7	8.6	11.8	7.0	10.2
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R												
			T												
	pH		R			8.4			8.3			8.4			8.3
			T			8.2			7.8			7.8			7.9
	Temperature	(^oC)		13.5	7.0	10.5	14.0	7.5	10.6	15.3	6.5	10.2	18.0	9.0	12.9
DEC	Turbidity (FTU)		R	31.0	2.8	12.8	51.0	2.2	23.7	23.0	2.8	8.1	22.0	3.4	9.3
			T	0.89	0.18	0.34	0.65	0.16	0.31	0.70	0.09	0.20	0.66	0.14	0.29
	Alum	(mg/L)		20.5	6.5	6.7	21.1	11.7	16.6	12.2	7.7	9.2	15.4	9.5	11.4
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. Al	(mg/L)	R						0.240						
			T						0.061						
	pH		R			8.3			8.1			8.3			8.2
			T			8.0			7.7			7.9			8.1
	Temperature	(^oC)		7.0	3.5	4.6	7.8	0.5	3.9	7.5	3.0	5.0	12.0	2.0	7.7

TABLE 2.1: PARTICULATE REMOVAL PROFILE (DEC/85)

WPOS NIAGARA FALLS WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^oC)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.10	1.45		0.62	11.74							7.5
2	35.0	2.38		0.60	13.99							7.5
3	37.0	2.86		0.56	17.81							6.0
4	30.0	2.66		0.35	18.32							6.0
5	18.0	2.25		0.56	18.70							7.7
6	15.0	2.11		0.50	18.32							7.7
7	11.0	2.10		0.33	14.47							6.9
8	22.0	2.75		0.24	14.41							6.7
9	17.0	2.7		0.23	14.69							6.5
10	12.0	2.73		0.38	13.93							6.5
11	12.0	2.48		0.38	16.37							6.0
12	12.0	1.97		0.52	13.80							6.0
13	11.0	2.4		0.27	14.41							5.5
14	12.0	2.47		0.53	15.18							5.5
15	24.0	2.79		0.35	14.73							5.5

Note: Raw and treated turbidities are daily maximums of readings taken every 4 hours.
Settled water turbidities displayed above are averages between Sections 1 and 2 of the plant.

TABLE 2.1 (DEC/85) (cont'd.)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	34.0	3.05		0.36	19.66							5.5
17	36.0	2.95		0.36	16.11							2.9
18	36.0	2.63		0.37	21.11							2.0
19	36.0	3.36		0.34	18.61							2.0
20	34.0	3.3		0.43	19.70							2.0
21	21.0	2.13		0.40	18.45							2.0
22	27.0	2.51		0.37	18.94							2.0
23	38.0	3.58		0.34	17.69							1.0
24	36.0	3.61		0.34	17.58							1.0
25	34.0	3.63		0.35	16.97							1.0
26	32.0	2.82		0.26	17.72							1.0
27	51.0	3.64		0.40	17.90							0.6
28	41.0	3.53		0.58	17.86							0.6
29	45.0	4.45		0.44	17.71							0.5
30	40.0	4.37		0.65	16.72							0.5
31	26.0	3.77		0.63	17.66							0.5

TABLE 2.2: PARTICULATE REMOVAL PROFILE (JAN/86)

WPOS NIAGARA FALLS WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	23.0	3.04		0.76	18.59							0.5
2	22.0	2.79		0.44	22.29							0.5
3	22.0	3.29		0.54	17.44							0.5
4	22.0	2.67		0.36	19.13							0.6
5	16.0	2.66		0.57	20.28							0.5
6	25.0	2.54		0.50	17.62							0.5
7	21.0	3.42		0.30	19.82							0.6
8	42.0	3.08		0.35	18.42							0.5
9	32.0	2.64		0.32	18.17							0.5
10	16.0	2.95		0.26	18.34							0.5
11	17.0	2.75		0.45	18.52							0.5
12	17.0	2.70		0.40	18.74							0.6
13	13.0	2.26		0.34	17.58							0.5
14	13.0	1.82		0.26	17.93							0.5
15	15.0	1.89		0.36	18.41							0.5

Note: Raw and treated turbidities are daily maximums of readings taken every 4 hours.
Settled water turbidities displayed above are averages between sections Sections 1 and 2 of the plant.

TABLE 2.2 (JAN/86) (cont'd.)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	8.0	2.01		0.18	17.80							0.5
17	7.3	1.78		0.29	17.43							0.6
18	17.0	1.40		0.35	41.44							0.7
19	7.6	1.97		0.26	16.53							0.6
20	9.0	2.68		0.39	15.86							0.6
21	9.5	2.82		0.36	16.33							0.6
22	10.0	1.89		0.29	15.45							0.6
23	8.6	1.76		0.21	19.23							0.6
24	7.3	1.64		0.20	16.20							0.7
25	8.3	1.51		0.35	17.05							0.6
26	6.8	1.54		0.33	15.88							0.6
27	4.8	1.38		0.37	15.40							0.6
28	5.2	1.44		0.37	13.47							0.5
29	5.1	1.73		0.16	14.64							0.5
30	6.3	2.20		0.30	13.92							0.5
31	6.3	1.99		0.35	13.87							0.6

TABLE 2.3: PARTICULATE REMOVAL PROFILE (FEB/84)

WPOS NIAGARA FALLS WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	2.7	2.60		0.30	6.43							5.0
2	2.6	2.68		0.46	7.01							6.0
3	2.8	2.68		0.37	7.63							6.0
4	2.6	2.55		0.36	5.24							6.0
5	2.6	2.55		0.34	6.72							6.0
6	2.6	2.52		0.45	6.54							6.0
7	2.7	2.46		0.41	6.30							5.0
8	2.6	2.58		0.44	6.43							5.0
9	5.0	2.5		0.43	6.30							2.0
10	2.6	2.56		0.58	6.34							5.0
11	2.8	2.61		0.48	6.28							5.0
12	2.7	2.68		0.50	6.26							5.0
13	3.4	3.1		0.52	6.48							5.0
14	7.5	4.75		0.72	11.29							6.0
15	6.4	4.15		0.57	9.86							6.0

Note: Raw and treated turbidities are daily maximums of readings taken every 4 hours.
Settled water turbidities displayed above are averages between Sections 1 and 2 of the plant.

TABLE 2.3 (FEB/84) (cont'd.)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	3.2	2.83		0.60	10.89							6.0
17	2.8	2.62		0.60	9.68							5.0
18	3.0	2.53		0.75	13.46							5.0
19	2.6	2.43		0.48	10.07							5.0
20	3.3	2.37		0.89	11.25							5.0
21	3.7	2.77		0.82	9.97							5.0
22	2.8	2.44		0.63	11.37							5.0
23	2.2	2.03		0.56	10.63							9.0
24	5.6	3.50		0.62	8.00							8.0
25	8.6	4.79		0.57	11.85							4.5
26	6.2	4.91		0.65	10.93							4.0
27	4.9	3.86		0.64	11.03							4.0
28	7.1	3.03		1.00	11.04							4.0
29	5.5	3.12		0.90	11.56							8.0

TABLE 2.4: PARTICULATE REMOVAL PROFILE (APR/84)

WPOS NIAGARA FALLS WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	1.7	1.77		0.34	11.40							0.5
2	1.6	1.72		0.43	12.87							1.5
3	1.8	1.66		0.42	13.72							1.5
4	1.9	1.69		0.49	13.19							1.5
5	14.0	4.41		0.56	11.50							1.4
6	8.0	4.33		0.97	-(1)							1.5
7	4.3	2.82		1.3	17.71							1.5
8	3.5	1.73		0.50	20.91							1.0
9	4.8	2.59		0.70	15.71							1.0
10	5.1	2.42		0.60	9.34							1.0
11	3.6	2.07		0.59	12.72							1.75
12	4.8	2.48		0.87	12.21							2.0
13	5.6	2.42		0.89	24.40							2.1
14	3.7	2.03		0.92	13.94							2.75
15	2.2	2.03		0.67	13.29							2.75

Note: Raw and treated turbidities are daily maximums of readings taken every 4 hours.
Settled water turbidities displayed above are averages between Sections 1 and 2 of the plant.

(1[redacted] Ta[redacted]ver[redacted]

TABLE 2.4 (APR/84) (cont'd.)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	1.6	2.08		0.75	16.08							5.0
17	9.8	2.58		0.88	17.97							3.3
18	2.5	2.65		0.75	15.13							3.5
19	2.0	2.32		0.85	18.24							3.5
20	1.8	1.63		0.57	11.91							3.5
21	1.8	1.89		0.56	10.13							3.5
22	1.7	1.71		0.52	11.07							3.5
23	1.4	1.70		0.37	10.82							3.7
24	1.9	1.62		0.65	11.78							3.5
25	1.8	2.48		0.93	21.14							3.8
26	5.2	2.30		0.65	12.15							4.0
27	3.7	2.31		0.65	11.99							4.5
28	2.6	2.00		0.44	11.61							5.3
29	2.2	1.92		0.41	11.51							4.9
30	2.6	1.81		0.54	12.28							5.5

TABLE 2.5: PARTICULATE REMOVAL PROFILE (MAY/84)

WPOS NIAGARA FALLS WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	7.0	4.77		0.58	5.23							5.0
2	14.0	5.82		1.60	9.28							6.0
3	11.0	3.65		1.30	15.36							6.0
4	15.0	2.94		0.80	22.55							4.5
5	15.0	3.54		0.75	15.60							5.0
6	11.0	2.74		0.46	17.46							5.0
7	6.0	2.33		0.52	17.51							5.5
8	9.2	2.21		0.64	18.02							5.5
9	9.1	2.87		0.53	13.26							6.1
10	8.5	2.54		0.67	17.22							6.2
11	6.5	2.51		0.85	17.70							6.0
12	3.5	1.31		0.58	18.04							7.1
13	3.8	1.95		0.58	19.04							7.6
14	3.4	1.91		0.65	16.97							7.4
15	7.4	1.63		0.54	18.36							11.0

Note: Raw and treated turbidities are daily maximums of readings taken every 4 hours.
Settled water turbidities displayed above are averages between Sections 1 and 2 of the plant.

TABLE 2.5 (MAY/84) (cont'd.)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. Al/Fe (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	2.8	1.37		0.55	17.54							8.0
17	2.1	1.29		0.60	17.33							9.0
18	1.7	1.39		0.47	15.06							8.5
19	1.6	1.43		0.47	13.87							8.5
20	2.3	1.64		0.63	14.30							8.5
21	1.8	1.69		0.60	13.54							8.5
22	1.9	1.56		0.64	12.63							9.5
23	1.8	1.48		0.81	14.61							9.5
24	1.8	1.57		0.63	14.55							10.5
25	2.0	1.42		0.55	13.17							11.3
26	1.5	1.23		0.60	14.49							10.9
27	1.6	1.18		0.56	13.11							11.2
28	1.2	1.17		0.46	16.13							11.0
29	1.1	1.08		0.44	12.53							10.3
30	3.5	1.33		0.47	11.47							10.5
31	1.5	1.24		0.51	14.16							10.5

TABLE 3.0: DISINFECTION SUMMARY

WPOS NIAGARA FALLS WTP

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand												
	Cl_2 Dosage	1.08	0.72	0.84				1.22	0.73	0.88			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.39	0.16	0.29				0.44	0.17	0.30			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.54	0.38	0.45				0.57	0.37	0.49
FEB	Cl_2 Demand												
	Cl_2 Dosage	0.90	0.56	0.78				1.11	0.62	0.82			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.37	0.15	0.26				0.52	0.17	0.29			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.50	0.37	0.43				0.57	0.38	0.49
MAR	Cl_2 Demand												
	Cl_2 Dosage	0.94	0.63	0.75				1.06	0.56	0.77			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.35	0.16	0.26				0.44	0.15	0.29			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.52	0.35	0.43				0.57	0.33	0.45

Note: Post-chlorination free and combined residuals should be included in the annual updates.

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand												
	Cl_2 Dosage	0.91	0.58	0.79				1.32	0.67	0.85			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.41	0.19	0.30				0.39	0.16	0.29			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.54	0.39	0.47				0.57	0.34	0.44
MAY	Cl_2 Demand												
	Cl_2 Dosage	1.13	0.71	0.96				1.57	0.80	1.11			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.40	0.12	0.24				0.40	0.11	0.26			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.54	0.34	0.44				0.55	0.34	0.44
JUN	Cl_2 Demand												
	Cl_2 Dosage	1.35	0.97	1.13				1.49	0.96	1.24			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.31	0.10	0.23				0.39	0.12	0.26			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.52	0.37	0.45				0.50	0.37	0.43

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand												
	Cl_2 Dosage	1.84	1.09	1.45				1.94	1.19	1.50			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.32	0.07	0.17				0.35	0.09	0.22			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.51	0.36	0.43				0.73	0.35	0.49
AUG	Cl_2 Demand												
	Cl_2 Dosage	2.02	1.34	1.61				1.83	1.01	1.46			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.32	0.09	0.19				0.37	0.10	0.24			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.55	0.43	0.48				0.59	0.37	0.49
SEP	Cl_2 Demand												
	Cl_2 Dosage	1.77	1.07	1.34				1.56	1.08	1.32			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.37	0.12	0.26				0.43	0.11	0.24			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.61	0.41	0.50				0.64	0.36	0.50

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand												
	Cl_2 Dosage	1.38	1.08	1.23				1.53	0.97	1.23			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.34	0.11	0.19				0.37	0.12	0.25			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.56	0.40	0.46				0.65	0.39	0.48
NOV	Cl_2 Demand												
	Cl_2 Dosage	1.36	1.01	1.21				1.43	0.92	1.19			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.68	0.10	0.24				0.41	0.14	0.25			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.63	0.42	0.52				0.63	0.37	0.48
DEC	Cl_2 Demand												
	Cl_2 Dosage	1.19	0.73	0.95				1.28	0.72	0.93			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.51	0.2	0.37				0.56	0.14	0.31			
	Resid. Cl_2 Comb.				0.85	0.29	0.53						
	Resid. Cl_2 Total										0.64	0.35	0.48

TABLE 3.0 (cont'd)

Footnotes:

Chlorine dosages are set or checked every 8 hours. Because pre and post chlorine is taken from the same cylinder, individual pre and post chlorine dosages cannot be determined. The dosage displayed in this table is the total Cl_2 dosage applied to the water. The set points for pre and post dosages are recorded.

Chlorine residuals are measured every 4 hours by Amperometric titration. The free residuals are measured on the effluents of the longest running filter in Section 1 and Section 2. The two sets of numbers were averaged to give the free residual data displayed in this table.

Post chlorine is applied before the high lift pumps. Post chlorine residual is measured at the high lift pump discharge.

WPOS NIAGARA FALLS WTP

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand												
	Cl_2 Dosage	1.21	0.05	0.87				1.18	0.67	0.89			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.39	0.07	0.26				0.77	0.5	0.11			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.58	0.42	0.51				0.53	0.33	0.42
FEB	Cl_2 Demand												
	Cl_2 Dosage	1.42	0.78	1.04				1.11	0.67	0.78			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.46	0.10	0.28				0.36	0.03	0.10			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.54	0.33	0.46				0.45	0.35	0.39
MAR	Cl_2 Demand												
	Cl_2 Dosage	1.26	0.86	1.05				0.93	0.58	0.76			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.42	0.10	0.24				0.11	0.03	0.07			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.57	0.42	0.48				0.46	0.33	0.37

Note: Post-chlorination free and combined residuals should be included in the annual updates.

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand												
	Cl_2 Dosage	1.41	0.97	1.18				1.06	0.73	0.90			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.42	0.14	0.28				0.11	0.02	0.07			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.54	0.35	0.44				0.50	0.32	0.41
MAY	Cl_2 Demand												
	Cl_2 Dosage	1.43	0.94	1.17				1.43	0.89	1.10			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.36	0.10	0.25				0.14	0.02	0.06			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.55	0.41	0.46				0.48	0.31	0.42
JUN	Cl_2 Demand												
	Cl_2 Dosage	2.10	1.09	1.50				1.34	1.00	1.19			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.71	0.10	0.22				0.12	0.02	0.05			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.63	0.36	0.48				0.49	0.33	0.42

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand												
	Cl_2 Dosage	2.07	1.21	1.52				2.00	1.12	1.35			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.47	0.08	0.24				0.17	0.03	0.05			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.68	0.43	0.52				0.52	0.34	0.43
AUG	Cl_2 Demand												
	Cl_2 Dosage	2.63	1.37	1.85				1.93	1.28	1.54			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.41	0.05	0.25				0.25	0.02	0.05			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.63	0.35	0.49				0.54	0.33	0.45
SEP	Cl_2 Demand												
	Cl_2 Dosage	1.76	0.89	1.26				1.68	1.28	1.50			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.45	0.15	0.34				0.10	0.02	0.05			
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total				0.62	0.40	0.50				0.53	0.40	0.46

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand Cl_2 Dosage	1.46	0.90	1.20				1.71	0.95	1.27			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.43	0.15	0.27				0.70	0.02	0.07			
	Resid. Cl_2 Comb. Resid. Cl_2 Total				0.55	0.41	0.49				0.62	0.40	0.47
NOV	Cl_2 Demand Cl_2 Dosage	1.43	0.73	1.12				1.17	0.86	1.01			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.42	0.18	0.31				0.22	0.03	0.07			
	Resid. Cl_2 Comb. Resid. Cl_2 Total				0.59	0.42	0.50				0.49	0.32	0.42
DEC	Cl_2 Demand Cl_2 Dosage	1.13	0.68	0.89				1.23	0.82	1.00			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	0.51	0.16	0.31				0.40	0.01	0.21			
	Resid. Cl_2 Comb. Resid. Cl_2 Total				0.61	0.36	0.49				0.54	0.34	0.47

TABLE 3.1 (cont'd)

Footnotes:

Chlorine dosages are set or checked every 8 hours. Because pre and post chlorine is taken from the the same cylinder, individual pre and post chlorine dosages cannot be determined. The dosage displayed in this table is the total chlorine dosage applied to the water. The set points for pre and post dosages are recorded.

Chlorine residuals are measured every 4 hours by Amperometric titration. The free residuals are measured on the effluents of the longest running filter in Section 1 and Section 2. These two sets of numbers were averaged to give the free residual data displayed in this table.

Post chlorine is applied before the high lift pumps. Post chlorine residual is measured at the high lift pump discharge.

TABLE 3.2: DISINFECTION PROFILE (DEC. 1985)

WPOS - NIAGARA FALLS WTP

DATE	PLANT TOTAL CHLORINE		PRE-CHLORINATION					POST-CHLORINATION						
			NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
1		1.14			0.38							0.48		0.63
2		1.09			0.36							0.39		0.53
3		1.03			0.30							0.36		0.49
4		1.05			0.33							0.39		0.52
5		1.08			0.30							0.37		0.49
6		0.99			0.36							0.39		0.52
7		1.12			0.32							0.39		0.52
8		0.90			0.33							0.31		0.44
9		0.91			0.21							0.29		0.42
10		0.80			0.18							0.30		0.44
11		1.28			0.28							0.50		0.64
12		0.82			0.28							0.32		0.44
13		0.81			0.32							0.32		0.44
14		0.82			0.39							0.25		0.35
15		0.82			0.30							0.30		0.43

TABLE 3.2 (cont'd.)

DATE	PLANT TOTAL CHLORINE		PRE-CHLORINATION					POST-CHLORINATION						
			NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
16		1.14			0.33							0.39		0.49
17		0.99			0.30							0.42		0.55
18		0.72			0.25							0.28		0.40
19		0.92			0.22							0.35		0.48
20		0.93			0.30							0.41		0.55
21		0.91			0.32							0.41		0.52
22		0.79			0.27							0.29		0.40
23		0.81			0.29							0.33		0.45
24		0.77			0.27							0.30		0.39
25		0.81			0.25							0.35		0.46
26		0.89			0.33							0.34		0.49
27		0.76			0.27							0.30		0.41
28		0.90			0.29							0.32		0.44
29		1.13			0.52							0.48		0.58
30		1.00			0.40							0.47		0.59
31		0.79			0.25							0.26		0.38

TABLE 3.3: DISINFECTION PROFILE (JAN. 1986)

WPOS - NIAGARA FALLS WTP

DATE	PLANT TOTAL CHLORINE		PRE-CHLORINATION					POST-CHLORINATION						
			NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
1		0.79			0.34							0.32		0.43
2		0.82			0.32							0.32		0.42
3		0.86			0.30							0.36		0.49
4		0.89			0.31							0.33		0.47
5		0.79			0.29							0.30		0.41
6		0.88			0.31							0.31		0.42
7		0.84			0.27							0.32		0.46
8		0.84			0.28							0.33		0.46
9		0.78			0.24							0.33		0.45
10		0.77			0.26							0.30		0.41
11		0.87			0.34							0.35		0.45
12		0.81			0.25							0.33		0.44
13		0.93			0.28							0.41		0.54
14		1.08			0.33							0.41		0.54
15		0.80			0.27							0.34		0.45

TABLE 3.3 (cont'd.)

DATE	PLANT TOTAL CHLORINE		PRE-CHLORINATION					POST-CHLORINATION						
			NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
16		0.92			0.28							0.36		0.49
17		0.86			0.29							0.37		0.49
18		0.84			0.29							0.31		0.43
19		0.78			0.21							0.27		0.38
20		0.82			0.25							0.33		0.45
21		0.87			0.32							0.35		0.46
22		0.85			0.27							0.36		0.49
23		0.91			0.26							0.34		0.48
24		0.90			0.27							0.32		0.43
25		0.86			0.28							0.32		0.49
26		0.68			0.27							0.30		0.44
27		0.76			0.28							0.34		0.46
28		0.72			0.21							0.29		0.39
29		0.86			0.37							0.38		0.50
30		0.80			0.24							0.31		0.42
31		0.77			0.22							0.30		0.42

TABLE 4.0: T&O CONTROL, ALKALINITY ADJ. &
FLUORIDATION SUMMARY

WPOS - NIAGARA FALLS WTP

		1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	PAC												
	$KMnO_4$												
	TON R												
	T												
	F Dos.												
	F Res.												
FEB	PAC												
	$KMnO_4$												
	TON R												
	T												
	F Dos.												
	F Res.												
MAR	PAC												
	$KMnO_4$												
	TON R												
	T												
	F Dos.												
	F Res.												
APR	PAC												
	$KMnO_4$												
	TON R												
	T												
	F Dos.												
	F Res.												
MAY	PAC												
	$KMnO_4$												
	TON R												
	T												
	F Dos.												
	F Res.												
JUN	PAC				1.85	1.54	1.68(2)						
	$KMnO_4$												
	TON R										1.25	0.2	0.93
	T										0.3	0.0	0.12
	F Dos.												
	F Res.												

TABLE 4.0 (cont'd.)

			1986			1985			1984			1983		
			MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	PAC				0	3.92	0.74	2.12	3.05	1.10	2.47(4)	4.40	1.56	2.69(6)
	$KMnO_4$													
	TON	R	0.40	0.00	0.20	1.40	0.00	0.422	1.00	0.00	0.4	1.20	0.00	0.575
		T	0.20	0.00	0.1	0.40	0.00	0.155	0.40	0.00	0.571	0.40	0.00	0.175
	F Dos.													
	F Res.													
AUG	PAC		1.12	0.28	0.99(1)	2.41	0.56	1.53	4.61	0.62	2.44(5)	3.63	0.72	2.57(7)
	$KMnO_4$													
	TON	R	0.75	0.00	0.22	0.20	0.00	0.066	1.00	0.00	0.288	2.00	0.00	1.066
		T	0.20	0.00	0.013	0.20	0.00	0.044	0.60	0.00	0.18	0.60	0.00	0.177
	F Dos.													
	F Res.													
SEP	PAC					0.76	0.76	0.76(3)						
	$KMnO_4$													
	TON	R	0.00	0.00	0.00	0.00	0.00	0.00						
		T				0.00	0.00	0.00						
	F Dos.													
	F Res.													
OCT	PAC													
	$KMnO_4$													
	TON	R												
		T												
	F Dos.													
	F Res.													
NOV	PAC													
	$KMnO_4$													
	TON	R												
		T												
	F Dos.													
	F Res.													
DEC	PAC													
	$KMnO_4$													
	TON	R												
		T												
	F Dos.													
	F Res.													

NOTE: Units used in this table are mg/L. No fluoride is added at this plant. PAC is added only when required for taste and odour control.

TABLE 4.0 - FOOTNOTES

(1) August 1986 - 15 days no PAC added.

(2) June 1985 - 27 days no PAC added.

(3) September 1985 - 29 days no PAC added.

(4) July 1984 - 21 days no PAC added.

(5) August 1984 - 3 days no PAC added.

(6) July 1983 - 20 days no PAC added.

(7) August 1983 - 5 days no PAC added.

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (AUG. 1986)

WPOS - NIAGARA FALLS WTP

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE	
						Dosage	Residual
1	1.01						
2	1.02						
3	1.07						
4	1.04						
5	1.01						
6	1.07						
7	1.12						
8	1.05						
9	1.11						
10	1.00						
11	1.03						
12	1.02						
13	1.03						
14	1.00						
15	0.96						

Note: No Fluoride is added at this plant.
PAC is added when required for taste and odour control.
Units used in this table are mg/L.

TABLE 4.1 (cont'd.)

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE Dosage	FLUORIDE Residual
16	0.28						
17	0						
18	0						
19	0						
20	0						
21	0						
22	0						
23	0						
24	0						
25	0						
26	0						
27	0						
28	0						
29	0						
30	0						
31	0						

TABLE 4.2: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (AUG. 1985)

WPOS - NIAGARA FALLS WTP

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE	
						Dosage	Residual
1	1.67						
2	1.57						
3	1.78						
4	1.91						
5	1.83						
6	2.41						
7	1.49						
8	1.52						
9	0.56						
10	1.19						
11	1.96						
12	0						
13	1.89						
14	2.25						
15	1.82						

TABLE 4.2 (cont'd.)

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE Dosage	FLUORIDE Residual
16	1.49						
17	2.17						
18	1.88						
19	1.62						
20	1.86						
21	1.82						
22	1.33						
23	1.00						
24	1.23						
25	1.07						
26	0.99						
27	0.98						
28	0.96						
29	1.04						
30	1.10						
31	0.89						

WPOS - NIAGARA FALLS WTP

GENERAL CHEMISTRY		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
GENERAL CHEMISTRY															
Alkalinity	R			(1) 104.6				96.8	(1) 96.6	96.7	102.5	95.7	99.6	0.2	
(mg/L)	T			94.8(1)				88.8	74.4 (1)	81.6	96.9	86.9	92.3	(mg/L)	
Ammonium (Total)	R									-	0.032	-	-	0.05	
(mg/L)	T									-	0.036	-	-	(mg/L)	
Calcium	R			(1) 37.5						36.0	38.5	34.0	36.0	0.1	
(mg/L)	T			38.7(1)						37.5	38.5	34.0	36.3	(mg/L)	
Chloride	R			(1) 16.0				(1) 16.2	14.8	15.5	17.3	14.5	15.3	0.2	250
(mg/L)	T			18.6				17.0	15.8	16.4	18.3	15.8	16.5	(mg/L)	(mg/L)
Colour	R			(2) 3.4				(1) 9.5	2.5	6.0				0.5	5
(TCU)	T			1.5(2)						-				(TCU)	(TCU)
Conductivity	R			(1) 299.0				298.0	(1) 286.0	292.0	305.0	274.0	290.0	0.01	
(umho/cm)	T			306.0(1)				303.0	301.0 (1)	302.0	307.0	277.0	293.9	(umho/cm)	
Field Chlorine	R													0.1	
(Combined)	T										1.18	0.05	0.23	(mg/L)	
Field Chlorine	R													0.1	
(Free)	T										0.550	0.100	0.32	(mg/L)	
Field Chlorine	R													0.1	
(Total)	T										0.700	0.150	0.43	(mg/L)	
Field pH	R										8.40	7.00	7.81	0.2	
	T										7.80	7.40	7.55		

GENERAL CHEMISTRY (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Field Temperature	R										24.0	0.50	8.70		
(^{o}C)	T										23.0	0.50	7.81		
Field Turbidity	R										10.00	1.10	3.54		1
(FTU)	T										0.46	0.13	0.29		(FTU)
Fluoride	R			(1) 0.12						0.120	0.150	0.110	0.128	0.01	2.4
(mg/L)	T			0.12(1)						0.100	0.140	0.090	0.117	(mg/L)	(mg/L)
Hardness	R			(1) 130.2				124.0	(1) 122.0	123.0	131.9	117.5	124.7	0.5	
(mg/L)	T			131.3(1)				128.0	125.0	126.5	131.9	117.5	125.5	(mg/L)	
Magnesium	R			(1) 8.90					(1)	8.30	9.20	7.90	8.42	0.05	
(mg/L)	T			8.45(1)						8.30	9.10	7.90	8.42	(mg/L)	c
Nitrate	R			(1) 0.2						0.300	0.345	-	0.280	0.05	10 (mg/L
(mg/L)	T			0.1(1)						0.250	0.355	0.240	0.284	(mg/L)	as N)
Nitrite	R			-						-	0.033	-	-	0.005	1 (mg/L
(mg/L)	T			-						-	0.007	-	-	(mg/L)	as N)
Nitrogen Total	R			-						-	0.29	0.12	0.23	0.1	0.15
Kjeldahl (mg/L)	T			-						-	0.19	-	0.15	(mg/L)	(mg/L) *
pH	R			(1) 8.37				(1) 8.39	8.12	8.26	8.42	8.10	8.27		
	T			7.86(1)				7.56	7.17	7.36	8.31	7.44	8.02		
Phosphorus Filtered	R								(1)	-	0.012	-	0.012	0.01	
Reactive (mg/L)	T									-			-	(mg/L)	

GENERAL CHEMISTRY (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Phosphorus (Total)	R									-	0.024	-	0.019	0.01	
(mg/L)	T									-			-	(mg/L)	
Sodium	R			(1) 9.0						9.00	10.00	8.40	9.10	0.1	
(mg/L)	T			9.5(1)						9.10	10.10	8.40	9.17	(mg/L)	
Total Solids	R									194.0	198.0	181.0	189.3	1	
(mg/L)	T									197.0	198.0	182.0	192.1	(mg/L)	
Turbidity	R			(1) 0.50				10.0	(1) 1.06	5.53	14.20	1.10	4.0	0.01	1
(FTU)	T			0.30(1)				0.22 (1)	0.10	0.16	0.55	0.08	0.25	(FTU)	(FTU)
METALS															
Aluminum	R			(1) 0.020						0.240	0.380	0.009	0.132	0.003	0.1
(mg/L)	T			0.770(1)						0.061	0.310	0.042	0.104	(mg/L)	(mg/L) G
Arsenic	R			-						-			-	0.001	0.05
(mg/L)	T			-						-			-	(mg/L)	(mg/L)
Barium	R			(1) 0.018						0.018	0.021	0.018	0.019	0.001	1
(mg/L)	T			0.017(1)						0.018	0.020	0.016	0.018	(mg/L)	(mg/L)
Beryllium	R			-(1)									-	0.001	
(mg/L)	T			-(1)									-	(mg/L)	
Boron	R									-	0.08	-	0.06	0.02	5
(mg/L)	T									0.03	0.08	-	0.05	(mg/L)	(mg/L)
Cadmium	R			-(1)						-	0.0004	-	-	0.0003	0.005
(mg/L)	T			-(1)						-			-	(mg/L)	(mg/L)

TABLE 5.0 (cont'd.)

METALS (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Chromium (mg/L)	R									0.004	0.003	<0.001	0.002	0.001 (mg/L)	0.05 (mg/L)
	T									0.002	0.002	<0.001	0.001		
Cobalt (mg/L)	R									<0.001	0.001	<0.001	<0.001	0.001 (mg/L)	
	T									0.001	<0.001	<0.001	<0.001		
Copper (mg/L)	R									0.004	0.047	0.001	0.010	0.001 (mg/L)	1 (mg/L)
	T									0.004	0.006	-	0.002		
Cyanide (mg/L)	R									-			-	0.001 (mg/L)	0.2 (mg/L)
	T									-			-		
Iron (mg/L)	R									0.26	0.34	0.031	0.12	0.002 (mg/L)	0.3 (mg/L) c
	T									0.004	0.005	0.003	0.004		
Lead (mg/L)	R									<0.003	0.005	<0.003	<0.003	0.003 (mg/L)	0.05 (mg/L)
	T									0.003	0.005	<0.003	<0.003		
Manganese (mg/L)	R									0.008	0.009	0.001	0.004	0.001 (mg/L)	0.05 (mg/L)
	T									0.002	0.002	<0.001	0.001		
Molybdenum (mg/L)	R									0.002	0.001	<0.001	<0.001	0.001 (mg/L)	
	T									0.002	0.001	<0.001	<0.001		
Mercury (ug/L)	R										0.040	<0.010	0.020	0.01 (ug/L)	1 (ug/L)
	T										0.020	<0.010	0.015		
Nickel (mg/L)	R									0.003	0.002	0.001	0.002	0.002 (mg/L)	
	T									0.002	0.009	0.001	0.002		

METALS (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Selenium	R			-(1)						-			-	0.001	0.01
(mg/L)	T			-(1) -(1)						-			-	(mg/L)	(mg/L)
Strontium	R			0.160						0.150	0.170	0.140	0.155	0.001	
(mg/L)	T			0.140(1)						0.160	0.180	0.140	0.155	(mg/L)	
Tin	R														
(no units available)	T														
Uranium	R									-			-	0.002	0.02
(mg/L)	T									-			-	(mg/L)	(mg/L) t
Vanadium	R			-(1)						-	0.003	-	-	0.001	
(mg/L)	T			-						-	0.002	-	-	(mg/L)	
Zinc	R			-(1)						0.004	0.012	-	0.009	0.001	5
(mg/L)	T			-(1)						0.005	0.013	-	0.005	(mg/L)	(mg/L) h
PURGEABLES															
Benzene	R									-			-	1	10
(ug/L)	T									-			-	(ug/L)	(ug/L) h
Bromoform	R									-	2.0		-	1	350
(ug/L)	T									-	2.0	-	2.0	(ug/L)	(ug/L) ++
Carbon Tetrachloride	R			-(1)						-			-	1	3
(ug/L)	T			-(1)						-			-	(ug/L)	(ug/L) h
Chlorobenzene	R									-			-	1	100-300
(ug/L)	T									-			-	(ug/L)	(ng/L) h*

PURGEABLES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Chlorodibromomethane	R			-(1)						-			-	1	350
(ug/L)	T			3.0(1)						16.00	13.00	5.00	8.62	(ug/L)	(ug/L) ++
Chloroform	R			-(1)						-			-	1	350
(ug/L)	T			11.0						20.00	18.00	10.00	14.38	(ug/L)	(ug/L) ++
1,2-Dichlorobenzene	R									-			-	1	400
(ug/L)	T									-			-	(ug/L)	(ug/L) e
1,3-Dichlorobenzene	R									-			-	1	400
(ug/L)	T									-			-	(ug/L)	(ug/L) e
1,4-Dichlorobenzene	R									-			-	1	400
(ug/L)	T									-			-	(ug/L)	(ug/L) e
Dichlorobromomethane	R									-			-	1	350
(ug/L)	T									14.00	11.00	8.00	9.75	(ug/L)	(ug/L) ++
1,1-Dichloroethane	R									-			-	1	
(ug/L)	T									-			-	(ug/L)	
1,2-Dichloroethane	R									-			-	1	10
(ug/L)	T									-			-	(ug/L)	(ug/L) h
1,1-Dichloroethylene	R									-			-	1	0.3
(ug/L)	T									-			-	(ug/L)	(ug/L) h
T,1,2-Dichloroethylene	R									-			-	1	
(ug/L)	T									-			-	(ug/L)	

PURGEABLES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Dichloromethane	R													5	40
(ug/L)	T													(ug/L)	(ug/L) c
1,2-Dichloropropane	R									-			-	1	
(ug/L)	T									-			-	(ug/L)	
Ethylbenzene	R									-			-	1	1400
(ug/L)	T									-			-	(ug/L)	(ug/L) e
Ethylene Dibromide	R												-		
(ug/L)	T												-		
M-Xylene	R									-			-	1	620
(ug/L)	T									-			-	(ug/L)	(ug/L) c
O-Xylene	R									-			-	1	620
(ug/L)	T									-			-	(ug/L)	(ug/L) c
P-Xylene	R									-			-	1	620
(ug/L)	T									-			-	(ug/L)	(ug/L) c
Toluene	R									-			-	1	100
(ug/L)	T									-			-	(ug/L)	(ug/L) c
1,1,2,2-Tetra-	R									-			-	1	1.7
chloroethane (ug/L)	T									-			-	(ug/L)	(ug/L) e
Tetrachloroethane	R			-(1)						-			-	1	10
(ug/L)	T			-(1)						-			-	(ug/L)	(ug/L) h

TABLE 5.0 (cont'd.)

PURGEABLES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
1,1,1-Trichloroethane	R									-			-	1	1000
(ug/L)	T									-			-	(ug/L)	(ug/L) c
1,1,2-Trichloroethane	R									-			-	1	6
(ug/L)	T									-			-	(ug/L)	(ug/L) e
Trichloroethylene	R			-(1)						-			-	1	30
(ug/L)	T			-(1)						-			-	(ug/L)	(ug/L) h
Total Trihalomethanes	R			-(1)						-			-	3	350
(ug/L)	T			21.0(1)						50.00	42.00	27.00	33.00	(ug/L)	(ug/L) ++
Trifluorochloro-	R									-			-	1	
toluene (ug/L)	T									-			-	(ug/L)	
ORGANOCHLORINES															
Aldrin	R			-(1)						-			-	1	700
(ng/L)	T			-(1)						-			-	(ng/L)	(ng/L) **
Alpha BHC	R			5.0(1)						-			-	1	700
(ng/L)	T			5.0(1)						-			-	(ng/L)	(ng/L) c
Alpha Chlordane	R			-(1)						-			-	2	700
(ng/L)	T			-(1)						-			-	(ng/L)	(ng/L) ***
Beta BHC	R			-(1)						-			-	1	300
(ng/L)	T			-(1)						-			-	(ng/L)	(ng/L) c
Dieldrin	R			-(1)						-			-	2	700
(ng/L)	T			-(1)						-			-	(ng/L)	(ng/L) **

TABLE 5.0 (cont'd.)

ORGANOCHLORINES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Endrin	R			-(1)						-			-	4	200
(ng/L)	T			-(1)						-			-	(ng/L)	(ng/L)
Gamma Chlordane	R			-(1)						-			-	2	700
(ng/L)	T			-(1)						-			-	(ng/L)	(ng/L) ***
Heptachlor Epoxide	R			-(1)										1	3000
(ng/L)	T			-(1)										(ng/L)	(ng/L) +++
Heptachlor	R			-(1)						-			-	1	3000
(ng/L)	T			-(1)						-			-	(ng/L)	(ng/L) +++
Hexachlorobenzene	R			-(1)						-			-	1	10
(ng/L)	T			-(1)						-			-	(ng/L)	(ng/L) h
Hexachlorobutadiene	R			-(1)						-			-		
(ug/L)	T			-(1)						-			-		
Hexachloroethane	R									-			-	1	19000
(ng/L)	T									-			-	(ng/L)	(ng/L) e
Lindane	R									-			-	1	4000
(ng/L)	T									-			-	(ng/L)	(ng/L)
Methoxychlor	R			-(1)						-			-	5	100000
(ng/L)	T			-						-			-	(ng/L)	(ng/L)
Mirex	R			-(1)						-			-	5	
(ng/L)	T			-(1)						-			-	(ng/L)	

TABLE 5.0 (cont'd.)

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Octachlorostyrene (ng/L)	R									-			-	1 (ng/L)	
	T									-			-		
O,P-DDT (ng/L)	R			-(1)						-			-	5 (ng/L)	30000 (ng/L) d
	T			-(1)						-			-		
Oxychlordane (ng/L)	R			-(1)						-			-	2 (ng/L)	
	T			-(1)						-			-		
PCB Total (ng/L)	R			-(1)						-			-	20 (ng/L)	3000 (ng/L) t
	T			-(1)						-			-		
Pentachlorobenzene (ng/L)	R									-			-	1 (ng/L)	74000 (ng/L) e
	T									-			-		
P,P-DDD (ng/L)	R			-(1)										5 (ng/L)	d
	T			-(1)											
P,P-DDE (ng/L)	R			-(1)						-			-	1 (ng/L)	d
	T			-(1)						-			-		
P,P-DDT (ng/L)	R			-(1)						-			-	5 (ng/L)	d
	T			-(1)						-			-		
1,2,3,4-Tetra-chlorobenzene (ng/L)	R									-			-	1 (ng/L)	
	T									-			-		
1,2,3,5-Tetra-chlorobenzene (ng/L)	R									-			-	1 (ng/L)	
	T									-			-		

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
1,2,4,5-Tetra-chlorobenzene (ng/L)	R									-			-	1 (ng/L)	38000 (ng/L) e
	T									-			-		
Thiodan I (ng/L)	R									-			-	2 (ng/L)	74000 (ng/L) ea
	T									-			-		
Thiodan II (ng/L)	R									-			-	4 (ng/L)	74000 (ng/L) ea
	T									-			-		
Thiodan Sulphate (ng/L)	R									-			-	4 (ng/L)	
	T									-			-		
Toxaphene (no units available)	R														
	T														
1,2,3-Trichlorobenzene (ng/L)	R									-			-	5 (ng/L)	10000 (ng/L) y
	T									-			-		
1,2,4-Trichlorobenzene (ng/L)	R									-			-	5 (ng/L)	15000 (ng/L) y
	T									-			-		
1,3,5-Trichlorobenzene (ng/L)	R									-			-	5 (ng/L)	10000 (ng/L) y
	T									-			-		
2,3,6-Trichlorotoluene (ng/L)	R									-			-	5 (ng/L)	
	T									-			-		
2,4,5-Trichlorotoluene (ng/L)	R									-			-	5 (ng/L)	10000 (ng/L) g
	T									-			-		

TRIAZINES		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
TRIAZINES															
2,6,A-Trichlorotoluene	R									-			-	5	
(ng/L)	T									-			-	(ng/L)	
Alachlor	R									-			-		
(ng/L)	T									-			-		
Ametrine	R									-			-	50	
(ng/L)	T									-			-	(ng/L)	
Atratone	R									-			-		
(ng/L)	T									-			-		
Atrazine	R									-			-	50	46000
(ng/L)	T									-			-	(ng/L)	(ng/L) !
Bladex	R									-			-	100	10000
(ng/L)	T									-			-	(ng/L)	(ng/L) !
Metolachlor	R														
(ng/L)	T														
Prometone	R									-			-	50	
(ng/L)	T									-			-	(ng/L)	
Prometryne	R									-			-	50	1000
(ng/L)	T									-			-	(ng/L)	(ng/L) !
Propazine	R									-			-	50	
(ng/L)	T									-			-	(ng/L)	

TRIAZINES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Sencor	R									-			-	100	
(ng/L)	T									-			-	(ng/L)	
Simazine	R									-			-	50	10000
(ng/L)	T									-			-	(ng/L)	(ng/L) !
SPECIAL PESTICIDES															
2,4-D	R									-			-	100	100000
(ng/L)	T									-			-	(ng/L)	(ng/L)
2,4-D Butyric Acid	R													200	18000
(ng/L)	T													(ng/L)	(ng/L) !
Dicamba	R												-	100	87000
(ng/L)	T												-	(ng/L)	(ng/L) !
Pentachlorophenol	R												-	50	10000
(ng/L)	T												-	(ng/L)	(ng/L) h
Picloram	R													100	
(ng/L)	T													(ng/L)	
2,4-D Propionic Acid	R												-	100	
(ng/L)	T												-	(ng/L)	
Silvex	R												-	50	10000
(ng/L)	T												-	(ng/L)	(ng/L)
2,4,5-T	R												-	50	
(ng/L)	T												-	(ng/L)	

SPECIAL PESTICIDES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
2,3,4,5-Tetra-chlorophenol (ng/L)	R												-	50 (ng/L)	
	T												-		
2,3,5,6-Tetra-chlorophenol (ng/L)	R												-	50 (ng/L)	
	T												-		
2,3,4-Trichlorophenol (ng/L)	R												-	100 (ng/L)	
	T												-		
2,4,5-Trichlorophenol (ng/L)	R												-	50 (ng/L)	
	T												-		
2,4,6-Trichlorophenol (ng/L)	R												-	50 (ng/L)	10000 (ng/L) h
	T												-		
ORGANOPHOSPHOROUS PEST'S.															
Diazinon (ng/L)	R													50 (ng/L)	14000 (ng/L)
	T														
Dichlorovos (ng/L)	R														
	T														
Dursban (ng/L)	R														
	T														
Ethion (ng/L)	R														
	T														
Guthion (ng/L)	R														
	T														

ORGANOPHOSPHOROUS PEST'S. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Malathion	R														
(ng/L)	T														
Methylparathion	R													50	7000
(ng/L)	T													(ng/L)	(ng/L)
Methyltrithion	R														
(ng/L)	T														
Mevinphos	R														
(ng/L)	T														
Parathion	R													50	35000
(ng/L)	T													(ng/L)	(ng/L)
Phorbate	R														
(ng/L)	T														
Reldan	R														
(ng/L)	T														
Ronnel	R														
(ng/L)	T														
MASS SPEC.															
Di-N-Butyl Phthalate	R												-	0.1	34000
(ug/L)	T												-	(ug/L)	(ug/L) e

TABLE 5.0 (cont'd.)

MASS SPEC. (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
N-Dichloromethylene-Pentachloroanaline (ug/L)	R												-	0.1 (ug/L)	
	T												-		
Diphenyl Ether (ug/L)	R												-	0.1 (ug/L)	
	T												-		
Fluoranthene (ug/L)	R												-	0.1 (ug/L)	
	T												-		
Hexachloropropene (ug/L)	R												-	0.1 (ug/L)	
	T												-		
Methyl Phenanthrene (ug/L)	R												-	0.1 (ug/L)	
	T												-		
Naphthalene (ug/L)	R												-	0.1 (ug/L)	
	T												-		
Pentachlorobutadiene (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropane (ug/L)	R												-	0.1 (ug/L)	
	T												-		
Pentachloropropene (ug/L)	R												-	0.1 (ug/L)	
	T												-		
Pyrene (ug/L)	R												-	0.1 (ug/L)	
	T												-		

MASS SPEC. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Tetrachlorbutane (ug/L)	R T												- -	0.1 (ug/L)	
Tetrachlorobiphenyl (ug/L)	R T													0.1 (ug/L)	
BACTERIA															
Raw Water:															
Total Coliform MF	R	5000	2	285	1400	2	209	6800	2	819	6900	2	887		
Total Coliform BKGD	R														
Fecal Coliform MF (count/100 mL)	R	62	2	10	96	2	28	220	2	59	250	1	47	0	0/0.1 (mL)
Standard Plate Count MF (count/mL)	R													0	500
Treated Water:															
Present/Absent Test	T														
Total Coliform Background MF (count/100 mL)	T	-	-	-	-	-	-	-	-	-	4	-	-	0	OWDO Bacti
Fecal Coliform MF (count/100 mL)	T													0	OWDO Bacti

TABLE 5.0 (cont'd.)

BACTERIA (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Treated Water (cont'd.)															
Standard Plate Count MF (counts/mL)	T										166	-	-		
If Present/Absent Test Positive:															
Coliform P/A	R														
	T														
Fecal Coliform P/A	R														
	T														
E. Coli P/A	R														
	T														
Aromonas P/A	R														
	T														
Staph. Aureus P/A	R														
	T														

TABLE 5.0 - FOOTNOTES

1	= see individual footnotes for agency of guideline origin
c	= California State Department of Health action level
d	= OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e	= USEPA ambient guideline
ea	= United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep	= USEPA proposed maximum contaminant level for drinking water
g	= suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h	= World Health Organization (WHO) guideline
h*	= World Health Organization (WHO) odour threshold
mg/L	= milligrams per litre, parts per million (ppm)
ng/L	= nanograms per litre, parts per trillion (ppt)
Presence/Absence	= microbiological test to indicate presence or absence of coliform bacteria
R	= raw water
T	= treated drinking water
t	= ODWO interim maximum acceptable concentration (IMAC)
ug/L	= micrograms per litre, parts per billon (ppb)
y	= New York State (taste and odour) proposed drinking water guideline
++	= total trihalomethanes
+++	= combined total: heptachlor and heptachlor epoxide
*	= if other than DWSP detection limit
**	= total of aldrin and dieldrin
***	= chlordane is a mixture of alpha and gamma isomers
!	= Ministry of the Environment and Health and Welfare Canada (IMAC)
-	= No quantifiable results. This includes readings that are non-detectable and readings that are detected but not quantifiable.
G	= ODWO suggested guideline
(1)	= These numbers were obtained from testing carried out by the Regional Municipality of Niagara previous to the inception of DWSP.
(2)	= These numbers are reported in HCU.

TABLE 5.1: WATER QUALITY (ONE-YEAR SUMMARY)

WPOS - NIAGARA FALLS WTP

GENERAL CHEMISTRY		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
GENERAL CHEMISTRY															
Alkalinity (mg/L)	R	102.2	99.2	101.6	95.7	98.7	98.9	97.7	96.2	98.0	100.7	103.9	102.2	0.2 (mg/L)	
	T	92.8	92.8	94.0	88.8	92.3	86.3	94.6	90.9	91.9	95.3	97.9	95.3		
Ammonium (Total) (mg/L)	R	-	-	-	-	-	-	-	-	0.28	0.14	-	-	0.05 (mg/L)	
	T	-	-	-	-	-	-	-	-	0.15	0.12	0.01	-		
Calcium (mg/L)	R	38.5	37.0	36.0	34.8	34.8	37.7	35.2	34.5	36.6	37.0	37.3	36.5	0.1 (mg/L)	
	T	38.5	37.5	36.5	35.4	35.5	37.7	35.3	34.6	36.5	37.5	37.3	37.3		
Chloride (mg/L)	R	15.4	14.8	17.3	15.0	15.5	15.0	14.5	14.5	15.0	15.5	15.0		0.2 (mg/L)	250 (mg/L)
	T	16.4	15.8	17.7	15.6	16.3	16.0	16.0	16.0	16.5	16.0	16.5			
Colour (TCU)	R	15.0	6.0	8.5	2.5	3.0	2.5	3.5	2.5	2.5	3.0	3.0	4.0	0.5 (TCU)	5 (TCU)
	T	0.5	1.0	1.0	0.5	1.0	0.5	1.5	1.5	1.0	0.5	1.0	1.5		
Conductivity (umho/cm)	R	246.0	305.0	300.0	278.0	285.0	287.0	274.0	275.0	282.5	290.0	292.0	293.0	0.01 (umho/cm)	
	T	304.0	301.0	307.0	280.0	289.0	296.0	277.0	280.0	287.0	293.0	297.0	296.0		
Field Chlorine (Combined)	R													0.1 (mg/L)	
	T	0.2	0.1	0.1	1.18	0.05	0.12	0.15	0.10	0.175	0.13	0.30	0.30		
Field Chlorine (Free)	R													0.1 (mg/L)	
	T	0.55	0.50	0.26	0.30	0.10	0.33	0.30	0.35	0.455	0.41	0.44	0.50		
Field Chlorine (Total)	R													0.1 (mg/L)	
	T	0.70	0.60	0.34	0.48	0.15	0.45	0.45	0.45	0.63	0.54	0.74	0.80		
Field pH	R	7.9	7.8	8.0	7.0	7.5	7.9	8.0	8.4	8.2	8.0	8.0	7.9	0.2	
	T	7.4	7.5	7.5	7.6	7.5	7.4	7.8	7.8	7.65	7.8	8.0	7.5		

TABLE 5.1 (cont'd.)

GENERAL CHEMISTRY (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Field Temperature	R	0.50	0.60	1.0	1.0	9.0	13.0	24.0	22.5	19.5	15.0	10.0	4.5		
(°C)	T	0.50	0.60	1.0	0.2	10.0	14.5	23.0	22.9	19.3	15.0	7.9	4.6		
Field Turbidity	R	10.0	3.1	6.6	1.1	1.8	1.3	3.0	2.4	2.2	1.7	5.5	18.9		1
(FTU)	T	0.14	0.25	0.33	0.36	0.31	0.13	0.19	0.22	0.19	0.20	0.34	0.33		(FTU)
Fluoride	R	0.13	0.12	0.13	0.11	0.12	0.15	0.14	0.12	0.12	0.13	0.11	0.12	0.01	2.4
(mg/L)	T	0.10	0.12	0.11	0.10	0.12	0.09	0.13	0.12	0.12	0.11	0.10	0.11	(mg/L)	(mg/L)
Hardness	R	131.9	129.0	128.0	119.5	120.0	130.0	121.5	120.0	125.5	126.0	129.0	125.0	0.5	
(mg/L)	T	131.9	130.0	129.0	121.0	121.5	129.5	122.0	120.5	124.7	128.0	129.0	127.5	(mg/L)	
Magnesium	R	8.70	8.80	9.20	7.90	8.05	8.65	8.15	8.25	8.25	8.20	8.70	8.30	0.05	
(mg/L)	T	8.70	8.70	9.10	7.90	8.00	8.55	8.25	8.25	8.20	8.35	8.80	8.40	(mg/L)	c
Nitrate	R	0.30	0.29	0.34	0.26	0.28	0.24	0.28						0.05	10 (mg/L
(mg/L)	T	0.30	0.28	0.36	0.27	0.28	0.24	0.24						(mg/L)	as N)
Nitrite	R	-	-	-	-	-	-	0.033	0.005	0.007	0.032	-	0.01	0.005	1 (mg/L
(mg/L)	T	-	-	-	-	-	-	0.007	0.005	0.004	-	-	0.006	(mg/L)	as N)
Nitrogen Total	R	0.22	0.20	0.21	0.24	0.12	0.26	0.29	0.25	0.25	0.22	0.23	0.27	0.1	0.15
Kjeldahl (mg/L)	T	0.15	0.13	0.14	0.15	-	0.16	0.19	0.20	0.175	0.21	0.26	0.12	(mg/L)	(mg/L) *
pH	R	8.10	8.12	8.31	8.33	8.36	8.42	8.34	8.39	8.55	8.38	8.23	8.37		
	T	7.44	7.72	8.25	8.08	8.13	8.05	8.31	8.14	8.19	8.22	7.93	8.23		
Phosphorus Filtered	R	0.12	-	0.024	-	0.012	-	0.021	0.003	0.002	-	0.004	0.005	0.01	
Reactive (mg/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(mg/L)	

TABLE 5.1 (cont'd.)

GENERAL CHEMISTRY (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Phosphorus (Total) (mg/L)	R	0.021	0.020	0.016	0.024	0.012	-	0.021	0.013	0.012		0.012	0.066	0.01 (mg/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Sodium (mg/L)	R	9.0	9.0	9.0	8.4	10.0	9.1	9.9	8.3	8.6	8.6	8.8	8.9	0.1 (mg/L)	
	T	9.0	9.0	9.0	8.4	10.1	9.1	9.8	8.2	8.45	8.0	8.7	9.0		
Total Solids (mg/L)	R	192.0	192.0	198.0	181.0	185.0	187.0		175.0	184.0	183.0	183.0	216.0	1 (mg/L)	
	T	198.0	193.0	196.0	182.0	188.0	192.0		189.0	187.0	190.0	193.0	167.0		
Turbidity (FTU)	R	14.2	3.4	4.4	1.2	3.3	1.1	2.7	1.21	2.5	2.1	5.5	26	0.01 (FTU)	1 (FTU)
	T	0.08	0.27	0.47	0.21	0.13	0.14	0.28	0.24	0.20	0.22	0.35	0.16		
METALS															
Aluminum (mg/L)	R	0.280	0.110	0.380	0.170	0.059	0.009	0.033	0.083	0.060	0.068	0.11	0.25	0.003 (mg/L)	0.1 (mg/L) G
	T	0.042	0.046	0.065	0.073	0.120	0.046	0.310	0.31	0.23	0.21	0.083	0.052		
Arsenic (mg/L)	R	-	-	-	-	-	-	-	0.001	-	-	-	-	0.001 (mg/L)	0.05 (mg/L)
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Barium (mg/L)	R	0.020	0.018	0.019	0.019	0.019	0.019	0.021	0.021	0.021	0.020	0.021	0.021	0.001 (mg/L)	1 (mg/L)
	T	0.017	0.016	0.017	0.018	0.018	0.019	0.020	0.019	0.020	0.019	0.020	0.018		
Beryllium (mg/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	0.001 (mg/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Boron (mg/L)	R	0.070	-	-	-	-	-	-	0.020	0.030	0.030	0.030	0.020	0.02 (mg/L)	5 (mg/L)
	T	0.080	-	-	-	-	-	-	0.020	0.035	0.030	0.030	0.020		
Cadmium (mg/L)	R	0.40	-	-	-	-	-	-	-	-	-	-	-	0.0003 (mg/L)	0.005 (mg/L)
	T	-	-	-	-	-	-	-	-	-	-	-	-		

METALS (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT*	DRINKING WATER OBJ GUIDELINE[1]
Chromium	R	0.002	0.003	0.002	-	-	-	-	-	-	-	-	0.001	0.001	0.05
(mg/L)	T	-	0.002	0.002	-	-	-	-	0.001	-	-	-	-	(mg/L)	(mg/L)
Cobalt	R	-	-	-	-	-	-	-	-	-	-	-	-	0.001	
(mg/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(mg/L)	
Copper	R	0.004	0.047	0.009	0.007	0.002	-	-	0.001	0.001	0.001	0.001	0.002	0.001	1
(mg/L)	T	0.003	0.004	0.005	-	-	-	-	-	0.001	0.001	-	0.001	(mg/L)	(mg/L)
Cyanide	R	-	-	-	-	-	-	-	-	-	-	-	-	0.001	0.2
(mg/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(mg/L)	(mg/L)
Iron	R	0.260	0.100	0.230	0.031	0.043	0.061	0.037	0.098	0.065	0.056	0.150	0.450	0.002	0.03
(mg/L)	T	0.004	0.004	0.004	0.005	-	0.005	0.003	0.014	0.010	0.003	0.002	0.002	(mg/L)	(mg/L) c
Lead	R	-	-	-	0.005	-	-	-	-	-	-	-	-	0.003	0.05
(mg/L)	T	-	-	-	0.005	-	-	-	-	0.003	-	-	-	(mg/L)	(mg/L)
Manganese	R	0.009	0.003	0.005	-	0.002	0.003	0.004	0.004	0.003	0.003	0.006	0.023	0.001	0.05
(mg/L)	T	0.002	-	0.002	-	-	-	-	0.001	0.001	0.001	0.001	0.001	(mg/L)	(mg/L)
Molybdenum	R	-	-	-	-	-	-	-	0.001	0.001	0.001	-	-	0.001	
(mg/L)	T	-	-	-	-	-	-	-	0.001	0.001	0.001	0.001	0.001	(mg/L)	
Mercury	R	-	0.040	0.015	0.020	-	0.020	0.020	0.020	0.040	0.040	0.050	0.060	0.01	1
(ug/L)	T	-	0.020	-	-	-	0.020	0.020	0.020	0.030	0.040	0.060	0.070	(ug/L)	(ug/L)
Nickel	R	-	-	-	-	-	-	-	0.002	-	-	-	-	0.002	
(mg/L)	T	0.009	-	-	-	-	-	-	-	0.004	-	-	-	(mg/L)	

TABLE 5.1 (cont'd.)

METALS (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Selenium (mg/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	0.001 (mg/L)	0.01 (mg/L)
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Strontium (mg/L)	R	0.160	0.150	0.170	0.150	0.140	0.160	0.140	0.160	0.150	0.150	0.160	0.150	0.001 (mg/L)	
	T	0.150	0.140	0.170	0.150	0.140	0.170	0.149	0.150	0.150	0.140	0.160	0.140		
Tin (no units available)	R														
	T														
Uranium (ug/L)	R	-	-	-	-	-	-	-	0.38	0.34	0.32	0.36	0.44	0.002 (mg/L)	0.02 (mg/L) t
	T	-	-	-	-	-	-	-	0.31	0.30	0.34	0.27	0.29		
Vanadium (mg/L)	R	-	0.002	0.003	-	-	-	-	0.001	-	-	-	-	0.001 (mg/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Zinc (mg/L)	R	0.006	0.023	0.011	0.012	0.002	0.004	-	-	0.017	0.001	0.001	0.007	0.001 (mg/L)	5 (mg/L) h
	T	0.005	0.003	0.003	0.013	0.001	0.005	-	0.001	0.023	-	-	0.004		
PURGEABLES															
Benzene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	10 (ug/L) h
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Bromoform (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	-	-	-	2.0	-	-	-	-	-	-	-	-		
Carbon Tetrachloride (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	3 (ug/L) h
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Chlorobenzene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	100-300 (ng/L) h*
	T	-	-	-	-	-	-	-	-	-	-	-	-		

PURGEABLES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT*	DRINKING WATER OBJ GUIDELINE[1]
Chlorodibromomethane (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	13.0	11.0	13.0	7.0	5.0	5.0	5.0	7.0	3.5	2.0	2.0	4.0		
Chloroform (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	14.0	12.0	18.0	10.0	17.0	15.0	16.0	27.0	22.0	20.0	20.0	16.0		
1,2-Dichlorobenzene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T	-	-	-	-	-	-	-	-	-	-	-	-		
1,3-Dichlorobenzene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T	-	-	-	-	-	-	-	-	-	-	-	-		
1,4-Dichlorobenzene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	400 (ug/L) e
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Dichlorobromomethane (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	11.0	9.0	11.0	8.0	11.0	10.0	9.0	14.0	11.0	10.0	11.0	10.0		
1,1-Dichloroethane (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
1,2-Dichloroethane (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	10 (ug/L) h
	T	-	-	-	-	-	-	-	-	-	-	-	-		
1,1-Dichloroethylene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	0.3 (ug/L) h
	T	-	-	-	-	-	-	-	-	-	-	-	-		
T,1,2-Dichloroethylene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		

PURGEABLES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Dichloromethane	R													5	40
(ug/L)	T													(ug/L)	(ug/L) c
1,2-Dichloropropane	R	-	-	-	-	-	-	-	-	-	-	-	-	1	
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	
Ethylbenzene	R	-	-	-	-	-	-	-	-	-	-	-	-	1	1400
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) e
Ethylene Dibromide	R					-	-	-	-	-	-	-	-		
(ug/L)	T					-	-	-	-	-	-	-	-		
M-Xylene	R	-	-	-	-	-	-	-	-	-	-	-	-	1	620
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) c
O-Xylene	R	-	-	-	-	-	-	-	-	-	-	-	-	1	620
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) c
P-Xylene	R	-	-	-	-	-	-	-	-	-	-	-	-	1	620
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) c
Toluene	R	-	-	-	-	-	-	-	-	-	-	-	-	1	100
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) c
1,1,2,2-Tetra-	R	-	-	-	-	-	-	-	-	-	-	-	-	1	1.7
chloroethane (ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ug/L)	(ug/L) e
Tetrachloroethane	R	-	-	-	-	-	-	-						1	10
(ug/L)	T	-	-	-	-	-	-	-						(ug/L)	(ug/L) h

PURGEABLES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
1,1,1-Trichloroethane (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	1000 (ug/L) c
	T	-	-	-	-	-	-	-	-	-	-	-	-		
1,1,2-Trichloroethane (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	6 (ug/L) e
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Trichloroethylene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	30 (ug/L) h
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Total Trihalomethanes (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	3 (ug/L)	350 (ug/L) ++
	T	38.0	32.0	42.0	27.0	33.0	30.0	30.0	48.0	36.5	32.0	33.0	30.0		
Trifluorochloro-toluene (ug/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ug/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
ORGANOCHLORINES															
Aldrin (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ng/L)	700 (ng/L) **
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Alpha BHC (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ng/L)	700 (ng/L) c
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Alpha Chlordane (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	2 (ng/L)	700 (ng/L) ***
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Beta BHC (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ng/L)	300 (ng/L) c
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Dieldrin (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	2 (ng/L)	700 (ng/L) **
	T	-	-	-	-	-	-	-	-	-	-	-	-		

TABLE 5.1 (cont'd.)

ORGANOCHLORINES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Endrin	R	-	-	-	-	-	-	-	-	-	-	-	-	4	200
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)
Gamma Chlordane	R	-	-	-	-	-	-	-	-	-	-	-	-	2	700
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) ***
Heptachlor Epoxide	R	-	-	-	-	-	-	-	-	-	-	-	-	1	3000
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) +++
Heptachlor	R	-	-	-	-	-	-	-	-	-	-	-	-	1	3000
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) +++
Hexachlorobenzene	R	-	-	-	-	-	-	-						1	10
(ng/L)	T	-	-	-	-	-	-	-						(ng/L)	(ng/L) h
Hexachlorobutadiene	R	-	-	-	-	-	-	-	-	-	-	-	-		
(ug/L)	T	-	-	-	-	-	-	-	-	-	-	-	-		
Hexachloroethane	R	-	-	-	-	-	-	-	-	-	-	-	-	1	19000
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) e
Lindane	R	-	-	-	-	-	-	-	-	-	-	-	-	1	4000
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)
Methoxychlor	R	-	-	-	-	-	-	-	-	-	-	-	-	5	100000
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L)
Mirex	R	-	-	-	-	-	-	-	-	-	-	-	-	5	
(ng/L)	T	-	-	-	-	-	-	-	-	-	-	-	-	(ng/L)	

TABLE 5.1 (cont'd.)

ORGANOCHLORINES (cont'd.)		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Octachlorostyrene (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ng/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
O,P-DDT (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	5 (ng/L)	30000 (ng/L) d
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Oxychlordane (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	2 (ng/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
PCB Total (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	20 (ng/L)	3000 (ng/L) t
	T	-	-	-	-	-	-	-	-	-	-	-	-		
Pentachlorobenzene (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ng/L)	74000 (ng/L) e
	T	-	-	-	-	-	-	-	-	-	-	-	-		
P,P-DDD (ng/L)	R													5 (ng/L)	d
	T														
P,P-DDE (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ng/L)	d
	T	-	-	-	-	-	-	-	-	-	-	-	-		
P,P-DDT (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	5 (ng/L)	d
	T	-	-	-	-	-	-	-	-	-	-	-	-		
1,2,3,4-Tetra-chlorobenzene (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ng/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		
1,2,3,5-Tetra-chlorobenzene (ng/L)	R	-	-	-	-	-	-	-	-	-	-	-	-	1 (ng/L)	
	T	-	-	-	-	-	-	-	-	-	-	-	-		

(Monthly columns JAN–DEC under the heading 1986.)

ORGANOCHLORINES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
1,2,4,5-Tetra-	R	-	-	-	-	-	-	-	-	-	-	-	-	1	38000
chlorobenzene (ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	(ng/L) e
Thiodan I	R	-	-	-	-	-	-	-	-	-	-	-	-	2	74000
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	(ng/L) ea
Thiodan II	R	-	-	-	-	-	-	-	-	-	-	-	-	4	74000
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	(ng/L) ea
Thiodan Sulphate	R	-	-	-	-	-	-	-	-	-	-	-	-	4	
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	
Toxaphene	R														
(no units available)	T														
1,2,3-Trichlorobenzene	R	-	-	-	-	-	-	-	-	-	-	-	-	5	10000
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	(ng/L) y
1,2,4-Trichlorobenzene	R	-	-	-	-	-	-	-	-	-	-	-	-	5	15000
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	(ng/L) y
1,3,5-Trichlorobenzene	R	-	-	-	-	-	-	-	-	-	-	-	-	5	10000
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	(ng/L) y
2,3,6-Trichlorotoluene	R	-	-	-	-	-	-	-	-	-	-	-	-	5	
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	
2,4,5-Trichlorotoluene	R	-	-	-	-	-	-	-	-	-	-	-	-	5	10000
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	(ng/L) g

TABLE 5.1 (cont'd.)

TRIAZINES		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
TRIAZINES															
2,6,A-Trichlorotoluene	R	-	-	-	-	-	-	-	-	-	-	-	-	5	
(ng/L)	T	-	-	-	-	-	-		-	-	-	-	-	(ng/L)	
Alachlor	R							-	-	-	-	-	-		
(ng/L)	T							-	-	-	-	-	-		
Ametrine	R				-	-	-	-	-	-	-	-	-	50	
(ng/L)	T				-	-	-	-	-	-	-	-	-	(ng/L)	
Atratone	R					-	-	-	-	-	-	-	-		
(ng/L)	T					-	-	-	-	-	-	-	-		
Atrazine	R				-	-	-	-	-	-	-	-	-	50	46000
(ng/L)	T				-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) !
Bladex	R				-	-	-	-	-	-	-	-	-	100	10000
(ng/L)	T				-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) !
Metolachlor	R								-	-	-	-	-		
(ng/L)	T								-	-	-	-	-		
Prometone	R				-	-	-	-	-	-	-	-	-	50	
(ng/L)	T				-	-	-	-	-	-	-	-	-	(ng/L)	
Prometryne	R				-	-	-	-	-	-	-	-	-	50	1000
(ng/L)	T				-	-	-	-	-	-	-	-	-	(ng/L)	(ng/L) !
Propazine	R				-	-	-	-	-	-	-	-	-	50	
(ng/L)	T				-	-	-	-	-	-	-	-	-	(ng/L)	

TABLE 5.1 (cont'd.)

TRIAZINES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Sencor (ng/L)	R				-	-	-	-	-	-	-	-	-	100 (ng/L)	
	T				-	-	-	-	-	-	-	-	-		
Simazine (ng/L)	R				-	-	-	-	-	-	-	-	-	50 (ng/L)	10000 (ng/L) !
	T				-	-	-	-	-	-	-	-	-		
SPECIAL PESTICIDES															
2,4-D (ng/L)	R				-				-	-				100 (ng/L)	100000 (ng/L)
	T				-				-	-					
2,4-D Butyric Acid (ng/L)	R													200 (ng/L)	18000 (ng/L) !
	T														
Dicamba (ng/L)	R				-				-	-				100 (ng/L)	87000 (ng/L) !
	T				-				-	-					
Pentachlorophenol (ng/L)	R				-				-	-				50 (ng/L)	10000 (ng/L) h
	T								-	-					
Picloram (ng/L)	R													100 (ng/L)	
	T														
2,4-D Propionic Acid (ng/L)	R				-				-	-				100 (ng/L)	
	T				-				-	-					
Silvex (ng/L)	R				-				-	-				50 (ng/L)	10000 (ng/L)
	T				-				-	-					
2,4,5-T (ng/L)	R				-				-	-				50 (ng/L)	
	T				-				-	-					

SPECIAL PESTICIDES (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
2,3,4,5-Tetra-	R				-				-	-				50	
chlorophenol (ng/L)	T				-				-	-				(ng/L)	
2,3,5,6-Tetra-	R				-				-	-				50	
chlorophenol (ng/L)	T				-				-	-				(ng/L)	
2,3,4-Trichlorophenol	R				-				-	-				100	
(ng/L)	T				-				-	-				(ng/L)	
2,4,5-Trichlorophenol	R				-				-	-				50	
(ng/L)	T				-				-	-				(ng/L)	
2,4,6-Trichlorophenol	R				-				-	-				50	10000
(ng/L)	T				-				-	-				(ng/L)	(ng/L) h
ORGANOPHOSPHOROUS PEST'S.															
Diazinon	R													50	14000
(ng/L)	T													(ng/L)	(ng/L)
Dichlorovos	R														
(ng/L)	T														
Dursban	R														
(ng/L)	T														
Ethion	R														
(ng/L)	T														
Guthion	R														
(ng/L)	T														

TABLE 5.1 (cont'd.)

ORGANOPHOSPHOROUS PEST'S. (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Malathion (ng/L)	R														
	T														
Methylparathion (ng/L)	R													50 (ng/L)	7000 (ng/L)
	T														
Methyltrithion (ng/L)	R														
	T														
Mevinphos (ng/L)	R														
	T														
Parathion (ng/L)	R													50 (ng/L)	35000 (ng/L)
	T														
Phorbate (ng/L)	R														
	T														
Reldan (ng/L)	R														
	T														
Ronnel (ng/L)	R														
	T														
MASS SPEC.															
Di-N-Butyl Phthalate (ug/L)	R			-										0.1 (ug/L)	34000 (ug/L) e
	T			-											

MASS SPEC. (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
N-Dichloromethylene-Pentachloroanaline	R													0.1	
(ug/L)	T													(ug/L)	
Diphenyl Ether	R			-										0.1	
(ug/L)	T			-										(ug/L)	
Fluoranthene	R			-										0.1	
(ug/L)	T			-										(ug/L)	
Hexachloropropene	R			-										0.1	
(ug/L)	T			-										(ug/L)	
Methyl Phenanthrene	R			-										0.1	
(ug/L)	T			-										(ug/L)	
Naphthalene	R			-										0.1	
(ug/L)	T			-										(ug/L)	
Pentachlorobutadiene	R			-										0.1	
(ug/L)	T			-										(ug/L)	
Pentachloropropane	R			-										0.1	
(ug/L)	T			-										(ug/L)	
Pentachloropropene	R			-										0.1	
(ug/L)	T			-										(ug/L)	
Pyrene	R			-										0.1	
(ug/L)	T			-										(ug/L)	

TABLE 5.1 (cont'd.)

MASS SPEC. (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Tetrachlorbutane (ug/L)	R			-										0.1 (ug/L)	
	T			-											
Tetrachlorobiphenyl (ug/L)	R													0.1 (ug/L)	
	T														
BACTERIA															
Raw Water:															
Total Coliform MF	R	3000	104	4300	98	4400	5	34	400	60	97	<2	1600		
Total Coliform BKGD	R	4600	3100	4700	5000	3000	2000	16000	50000	7100	37000	74	14000		
Fecal Coliform MF (count/100 mL)	R	36	7	70	6	102	2	8	45	16	3	0	119	0	0/0.1 (mL)
Standard Plate Count MF (count/mL)	R	410	950	720	2000	0	0	0	2400	350	2400	73	2400	0	500
Treated Water:															
Present/Absent Test	T														
Total Coliform Background MF (count/100 mL)	T	0	0	0	0	0	0	0	0	2	0	0	1	0	OWDO Bacti
Fecal Coliform MF (count/100 mL)	T													0	OWDO Bacti

BACTERIA (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Treated Water (cont'd.)															
Standard Plate Count MF (counts/mL)	T	0	1	3	1	2	2	2	5	2	4	93	166		
If Present/Absent Test Positive:															
Coliform P/A	R T														
Fecal Coliform P/A	R T														
E. Coli P/A	R T														
Aromonas P/A	R T														
Staph. Aureus P/A	R T														

TABLE 5.1 - FOOTNOTES

1	= see individual footnotes for agency of guideline origin
c	= California State Department of Health action level
d	= OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e	= USEPA ambient guideline
ea	= United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep	= USEPA proposed maximum contaminant level for drinking water
g	= suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h	= World Health Organization (WHO) guideline
h*	= World Health Organization (WHO) odour threshold
mg/L	= milligrams per litre, parts per million (ppm)
ng/L	= nanograms per litre, parts per trillion (ppt)
Presence/Absence	= microbiological test to indicate presence or absence of coliform bacteria
R	= raw water
T	= treated drinking water
t	= ODWO interim maximum acceptable concentration (IMAC)
ug/L	= micrograms per litre, parts per billon (ppb)
y	= New York State (taste and odour) proposed drinking water guideline
++	= total trihalomethanes
+++	= combined total: heptachlor and heptachlor epoxide
*	= if other than DWSP detection limit
**	= total of aldrin and dieldrin
***	= chlordane is a mixture of alpha and gamma isomers
!	= Ministry of the Environment and Health and Welfare Canada (IMAC)
-	= No quantifiable results. This includes readings that are non-detectable and readings that are detected but not quantifiable.
G	= ODWO suggested guideline

TABLE 7.0: Bacteriological Testing (1986)

WPOS - NIAGARA FALLS WTP

		TOTAL COLIFORM			FECAL COLIFORM			FECAL STREP			AEROMONAS/PSEUDO AEROG/OTHERS		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	R	5200	300	2167	192	68	142	94	12	47			
	T			0									
FEB	R	700	208	499	106	20	65	10	4	8			
	T			0									
MAR	R	174	6	71	38	2	14	6	2	3			
	T			0									
APR	R	700	230	371	66	6	51	24	4	13			
	T			0									
MAY	R	6900	30	2430	122	2	43	90	2	31			
	T			0									
JUN	R	6200	84	1796	250	1	66						
	T			0									
JUL	R	400	44	175	24	2	10						
	T			Absent									
AUG	R	164	18	91	24	14	15						
	T			Absent									
SEP	R	3700	60	1333	70	6	34						
	T			Absent									
OCT	R	1800	92	798	198	4	66						
	T			Absent									
NOV	R			24			6						
	T			Absent									
DEC	R												
	T												

Note: The above test results are per 100 ml sample. Samples are collected weekly and sent to the MOE lab, Resources Road, Rexdale, for analysis.
A (0) in the average column indicates that all the tests for the month yielded negative results.
Blanks indicate no tests performed.

TABLE 7.1: Bacteriological Testing (1985)

WPOS - NIAGARA FALLS WTP

		TOTAL COLIFORM			FECAL COLIFORM			FECAL STREP			AEROMONAS/PSEUDO AEROG/OTHERS		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	R	800	114	349	90	34	52	118	4	30			
	T			0									
FEB	R	1100	238	500	134	66	91	30	6	14			
	T	1	0	0									
MAR	R	2200	154	882	150	46	81	42	4	19			
	T			0									
APR	R	210	118	160	62	14	30	12	4	7			
	T			0									
MAY	R	700	58	291	46	2	17	16	2	7			
	T			0									
JUN	R	46	6	21	2	2	2	2	2	2			
	T			0									
JUL	R	3200	2	940	198	2	48	12	2	4			
	T			0									
AUG	R	2700	2300	2500	220	2	143	12	2	6			
	T			0									
SEP	R	2100	78	759	208	4	59	8	2	3			
	T			0									
OCT	R	300	28	98	6	2	3	2	2	2			
	T			0									
NOV	R	6800	900	2575	136	72	99	166	14	53			
	T	2	0	1									
DEC	R	1200	2	748	148	2	88	132	2	37			
	T			0									

Note: The above test results are per 100 ml sample. Samples are collected weekly and sent to the MOE lab, Resources Road, Rexdale, for analysis.
A (0) in the average column indicates that all the tests for the month yielded negative results.
Blanks indicate no tests performed.

TABLE 7.2: Bacteriological Testing (1984)

WPOS - NIAGARA FALLS WTP

		TOTAL COLIFORM			FECAL COLIFORM			FECAL STREP			AEROMONAS/PSEUDO AEROG/OTHERS		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	R	100	58	72	58	16	43	12	4	7			
	T			0									
FEB	R	600	20	186	74	12	36	108	4	33			
	T			0									
MAR	R	252	62	153	70	32	49	28	4	17			
	T			0									
APR	R	600	76	312	62	30	45	12	2	5			
	T			0									
MAY	R	300	2	131	96	2	38	4	2	2			
	T			0									
JUN	R	800	2	285	40	2	13	170	2	44			
	T			0									
JUL	R	280	8	114	12	2	6	2	2	2			
	T			0									
AUG	R	400	10	112	32	4	14	10	2	6			
	T			0									
SEP	R	40	10	29	10	2	6	10	2	5			
	T			0									
OCT	R	20	4	14	4	2	2	2	2	2			
	T			0									
NOV	R	276	22	149	56	2	21	14	2	7			
	T			0									
DEC	R	1400	250	950	94	50	59	22	10	15			
	T			0									

Note: The above test results are per 100 ml sample. Samples are collected weekly and sent to the MOE lab, Resources Road, Rexdale, for analysis.
A (0) in the average column indicates that all the tests for the month yielded negative results.
[illegible]ank[illegible]dic[illegible]no [illegible]s p[illegible]rme[illegible]

TABLE 7.3: Bacteriological Testing (1983)

WPOS - NIAGARA FALLS WTP

		TOTAL COLIFORM			FECAL COLIFORM			FECAL STREP			AEROMONAS/PSEUDO AEROG/OTHERS		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	R	132	26	79	34	8	21	18	6	13			
	T			0									
FEB	R	166	22	77	12	6	3	4	2	2			
	T			0									
MAR	R	144	10	60	18	2	8	4	2	3			
	T			0									
APR	R	110	18	49	16	2	7	2	2	2			
	T			0									
MAY	R	3100	2	684	12	2	5	26	2	9			
	T			0									
JUN	R	800	10	215	2	2	2	2	2	2			
	T			0									
JUL	R	100	6	54	8	2	4	4	2	3			
	T			0									
AUG	R	1700	10	477	4	2	2	4	2	2			
	T			0									
SEP	R	5000	10	1260	8	2	4	4	4	4			
	T			0									
OCT	R	50	10	20	10	2	4	10	4	5			
	T			0									
NOV	R	180	28	119	38	2	17	8	4	5			
	T	1	0	0									
DEC	R	830	102	335	62	6	38	40	8	20			
	T			0									

Note: The above test results are per 100 ml sample. Samples are collected weekly and sent to the MOE lab, Resources Road, Rexdale, for analysis.
A (0) in the average column indicates that all the tests for the month yielded negative results.
Blanks indicate no tests performed

TABLE 8.0: ALERT LEVELS
(TREATED WATER AT PLANT)

WPOS - NIAGARA FALLS WTP

DATE	PARAMETER	MEASURED PARAMETER	GUIDELINE LIMIT
Nov/85	Total Coliform	2/100 in 25% of monthly samples	5 in 10% of monthly samples (1)

(1) ODWO Limit for poor water quality.

During the summer and autumn months of each year (June - Nov.), the temperature exceeds the guideline limit of 15°C.

APPENDIX B

FILTER BACKWASHING GUIDELINES AND PROCEDURE

NIAGARA FALLS WATER PLANT
GUIDELINE FOR BACKWASHING FILTERS IN SECTION NO. 1

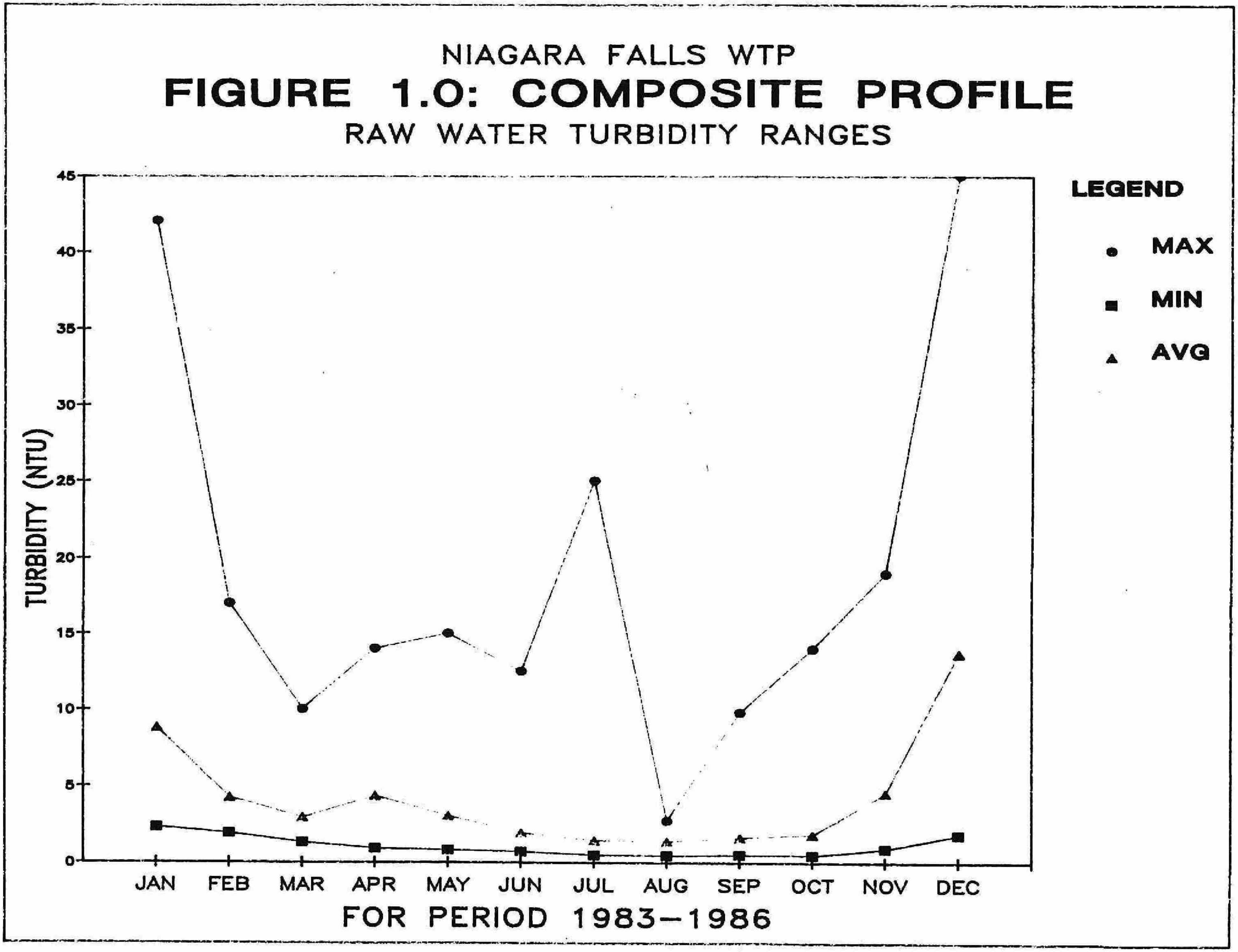
This guideline is for the consecutive backwashing of both components, A and B, of the dual filters in Section No. 1.

STEP NO.	FILTER "A"	FILTER "B"
1	Start an additional Low Lift pump if the raw water flow rate is near the total capacity of the ones that are already running.	
2	Close INFLUENT valve (hold toggle).	Close INFLUENT valve.
3	Shut off EFFLUENT by adjusting filter of flow to zero.	
4	Open DRAIN valve.	Open DRAIN valve.
5	Turn on AGITATOR.	
6	Turn WASH PUMP selector to LOW.	
7	Open WASH valve.	
8	Turn WASH PUMP selector to HIGH.	
9	Turn off AGITATOR.	
10	Turn WASH PUMP selector to LOW.	Turn on AGITATOR.
11		Open WASH valve.
12		Turn WASH PUMP selector to LOW.
13	Close WASH valve.	
14	Turn WASH PUMP selector to OFF.	
15	Close DRAIN valve.	
16	Crack open INFLUENT valve.	Turn WASH PUMP selector to HIGH.
17		Turn off AGITATOR.
18		Turn WASH PUMP selector to LOW.
19		Turn WASH PUMP selector to OFF.
20		Close WASH valve when backwash water stops.
21		Close DRAIN valve.
22		Crack open INFLUENT valve.
23	When water level stabilizes, fully open INFLUENT valve.	Fully open INFLUENT valve.
24	Set EFFLUENT rate of flow to 50%.	
25	Stop Low Lift pump, if one was started just for backwashing filters.	

Backwash procedure for Section 2 is the same except the filters are not paired.

APPENDIX C

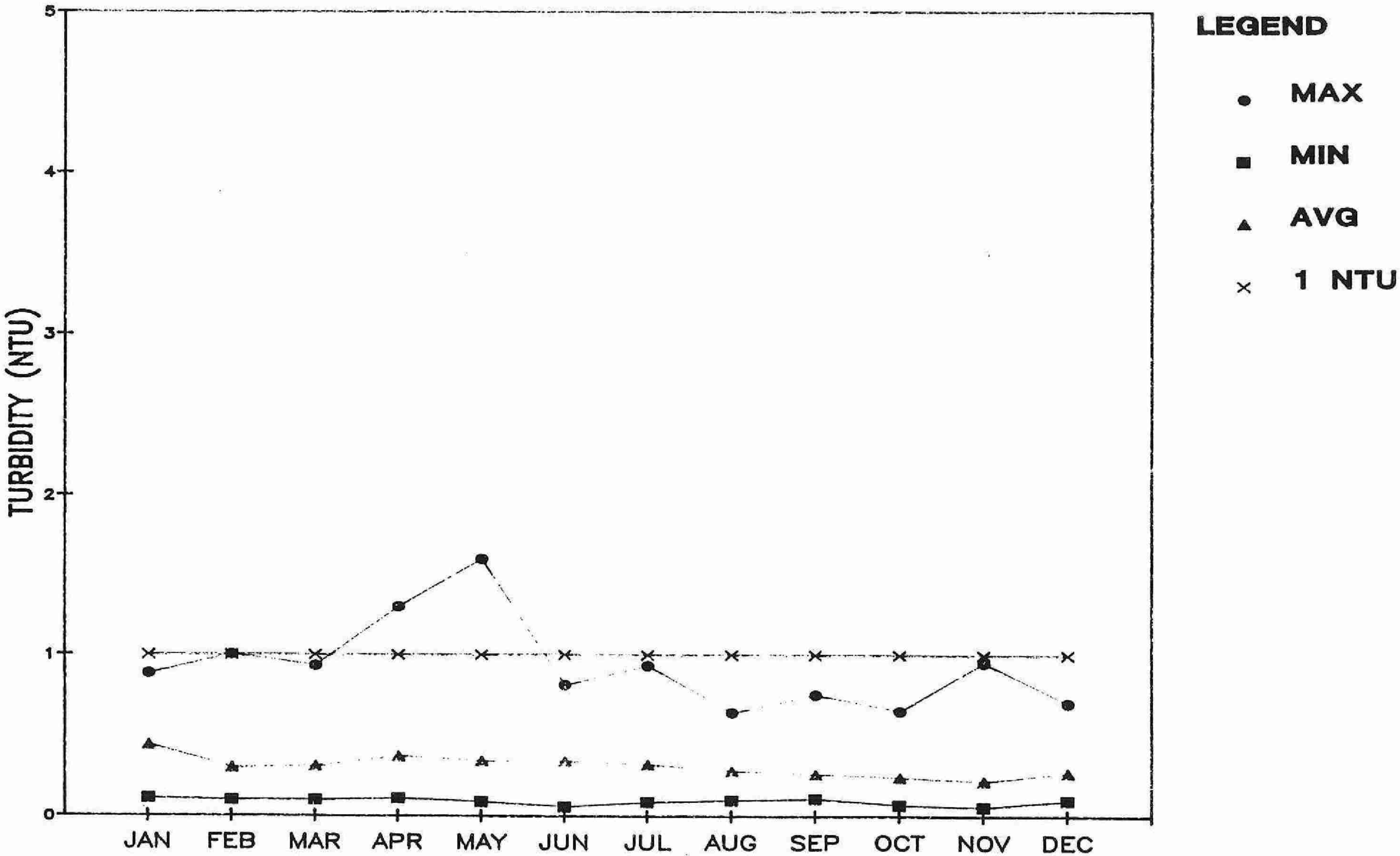
GRAPHICAL TURBIDITY DATA


NIAGARA FALLS WTP
FIGURE 1.0: COMPOSITE PROFILE
RAW WATER TURBIDITY RANGES
TURBIDITY (NTU)
45
40
35
30
25
20
15
10
5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
FOR PERIOD 1983–1986
LEGEND
MAX
MIN
AVG

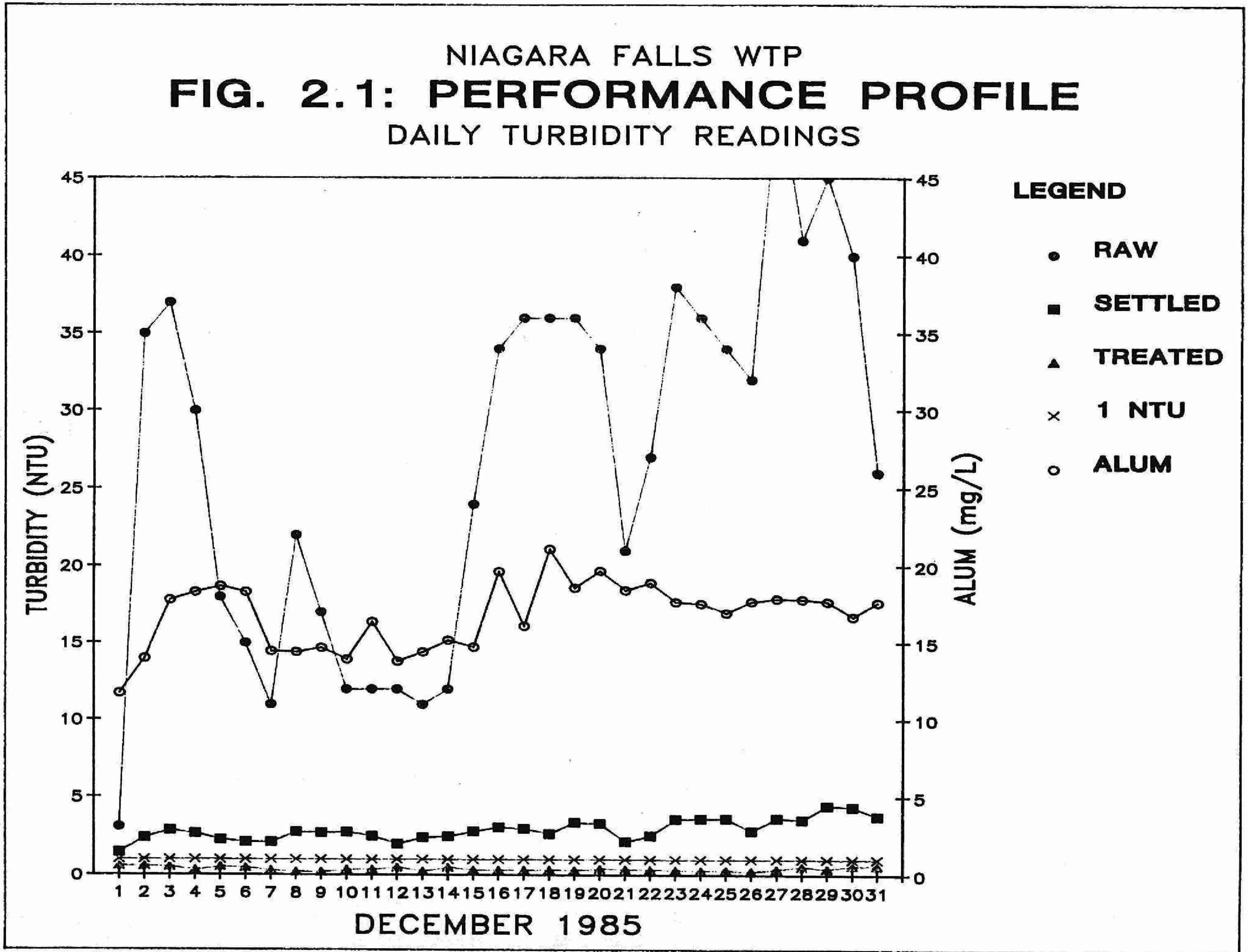
NIAGARA FALLS WTP

FIG. 1.1: COMPOSITE PERFORMANCE PROFILE

TREATED WATER TURBIDITY RANGES



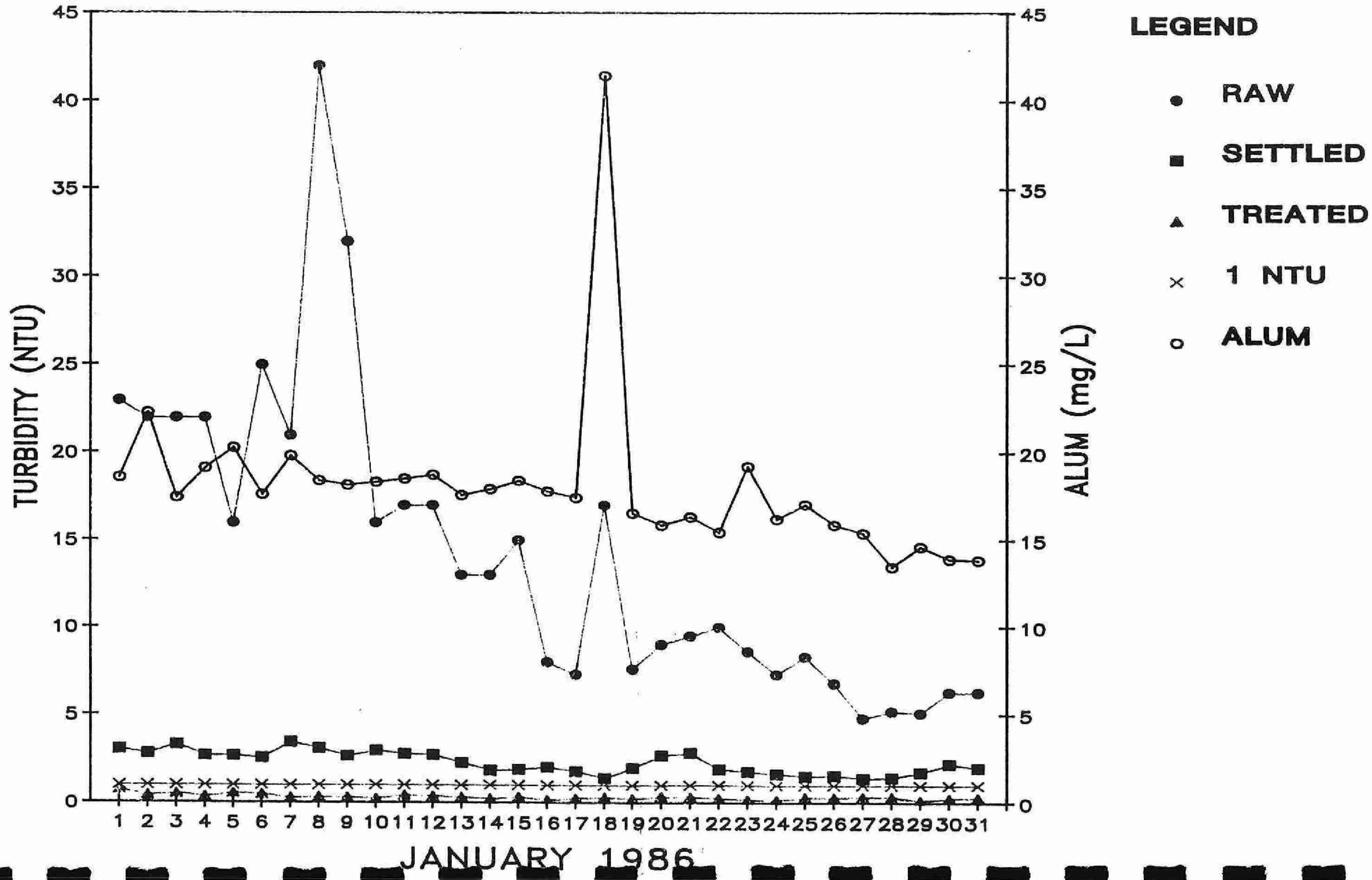
FOR PERIOD 1983 - 1986


NIAGARA FALLS WTP
FIG. 2.1: PERFORMANCE PROFILE
DAILY TURBIDITY READINGS
45
40
35
30
25
20
15
10
5
0
TURBIDITY (NTU)
ALUM (mg/L)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DECEMBER 1985
LEGEND
RAW
SETTLED
TREATED
1 NTU
ALUM

NIAGARA FALLS WTP

FIG. 2.2: PERFORMANCE PROFILE

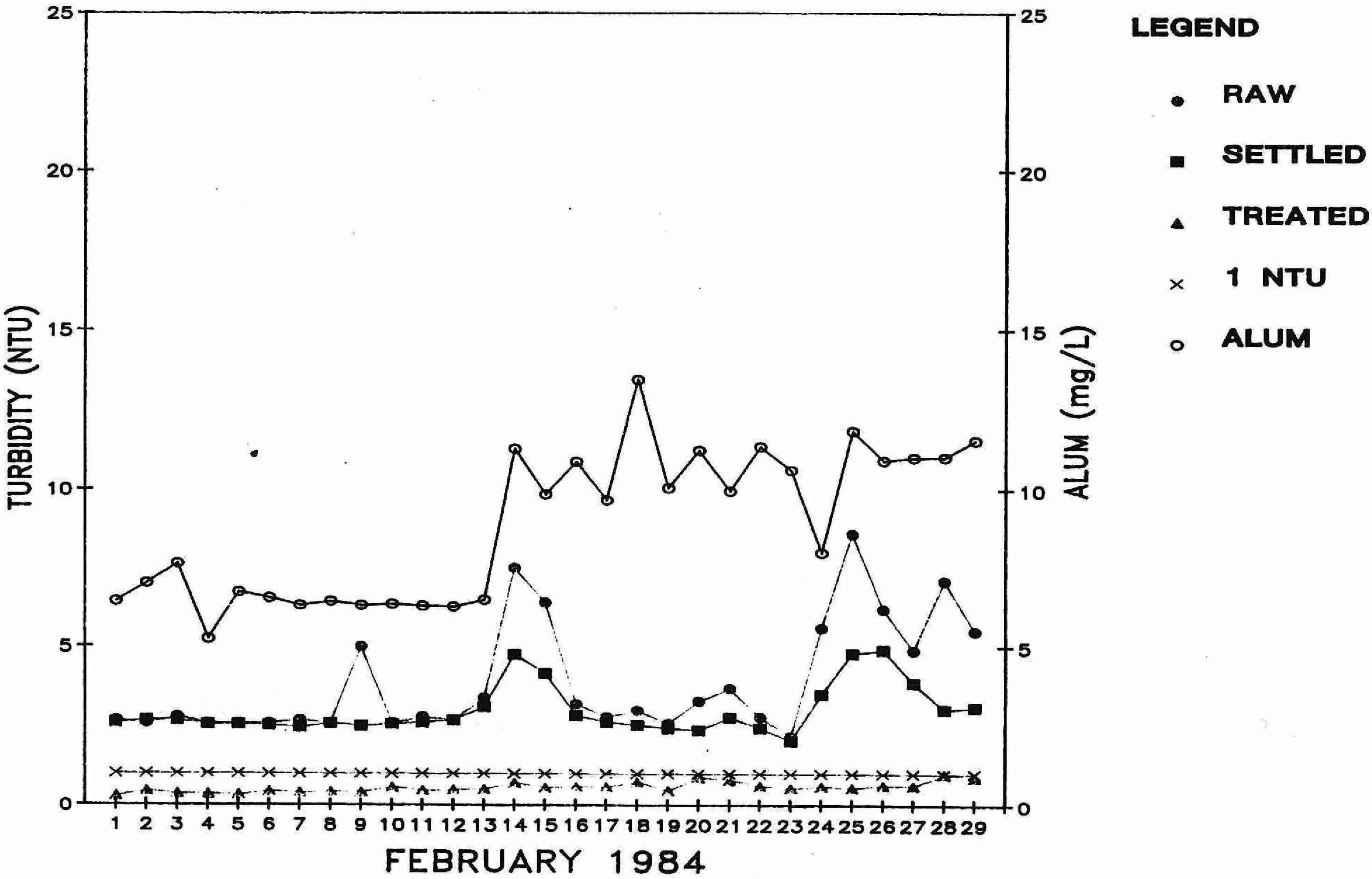
DAILY TURBIDITY READINGS



NIAGARA FALLS WTP

FIGURE 2.3: PERFORMANCE PROFILE

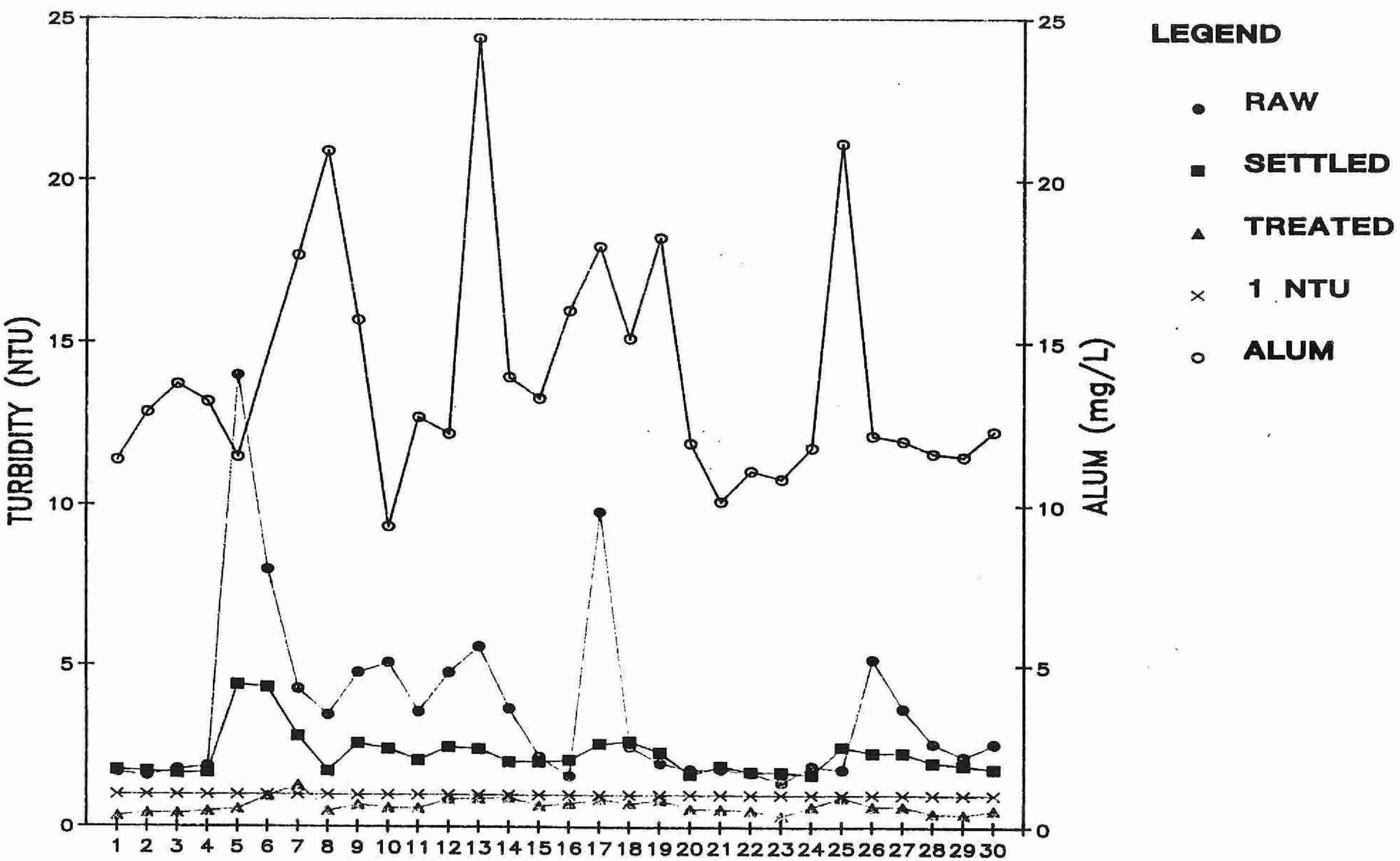
DAILY TURBIDITY READINGS

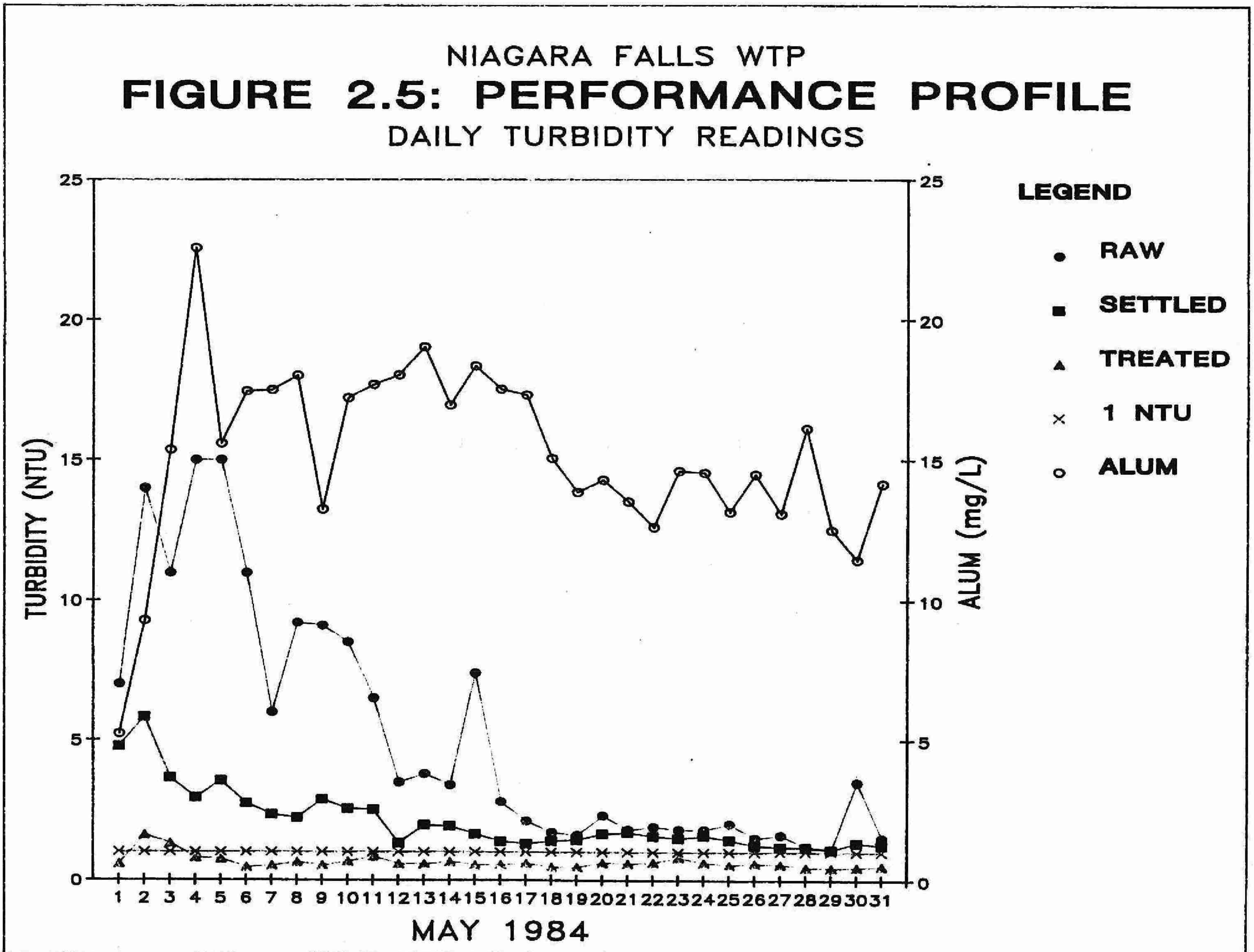


NIAGARA FALLS WTP

FIGURE 2.4: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS




NIAGARA FALLS WTP
FIGURE 2.5: PERFORMANCE PROFILE
DAILY TURBIDITY READINGS
TURBIDITY (NTU)
ALUM (mg/L)
0
5
10
15
20
25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY 1984
LEGEND
RAW
SETTLED
TREATED
1 NTU
ALUM

APPENDIX D

JAR TESTING

NIAGARA FALLS

Jar Test Procedure

The MSTS test procedure that was used for all testing carried out on Niagara Falls raw water was as follows:

1. Two hundred mL sample used.

2. Two minutes fast mix.

3. Thirty minutes flocculation mixing.

4. Thirty minutes settling time.

5. Filtration through a Whatman glass microfibre filter, followed by 1.2 μm filter.

The MSTS test procedure is a technique developed by Gore & Storrie Limited which has been shown to provide overall results similar to full scale conventional plant operations consisting of coagulation, flocculation, sedimentation and dual media filtration.

LABORATORY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
22 Nov. 86	MOE Water Plant Optimization Study Niagara Falls WTP	380.61

SAMPLE NO. & DESCRIPTION

1. Niagara Falls raw water (collected Nov. 6/86)

PARAMETERS	SAMPLE NO. 1	SAMPLE NO.	SAMPLE NO.	SAMPLE NO.
pH	7.51			
Colour (TCU)	<5			
Turbidity (NTU)	1.2			
Alkalinity (mg/L as $CaCO_3$)	98			
Hardness (mg/L as $CaCO_3$)	139			
Iron (mg/L)				
Manganese (mg/L)				

COMMENTS

CONDUCTED BY Wendy Gray | REVIEWED BY AWG.

Gore & Storrie Limited

TEST NO. 1

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
22 Nov. 86	MOE Water Plant Optimization Study Niagara Falls WTP	380.61

TEST DESCRIPTION

Removal of Turbidity with Alum

JAR NO.	CHEMICAL DOSAGES (mg/L) Alum	Floc Rating		WATER QUALITY AFTER TREATMENT pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	5	5		7.48	0.26	<5	90	130	
2	10	5		7.43	0.15	<5	86	130	
3	15	4		7.33	0.15	<5	80	130	
4	20	4		7.25	0.16	<5	78	131	
5	25	4		7.30	0.14	<5	76	131	
6	30	3		7.15	0.18	<5	74	130	
RAW, UNTREATED				7.51	1.2	<5	98	139	

SAMPLE TEMPERATURE Start: 9°C Finish: 23°C

COMMENTS

Floc Rating 1- very good

2- good

3- poor

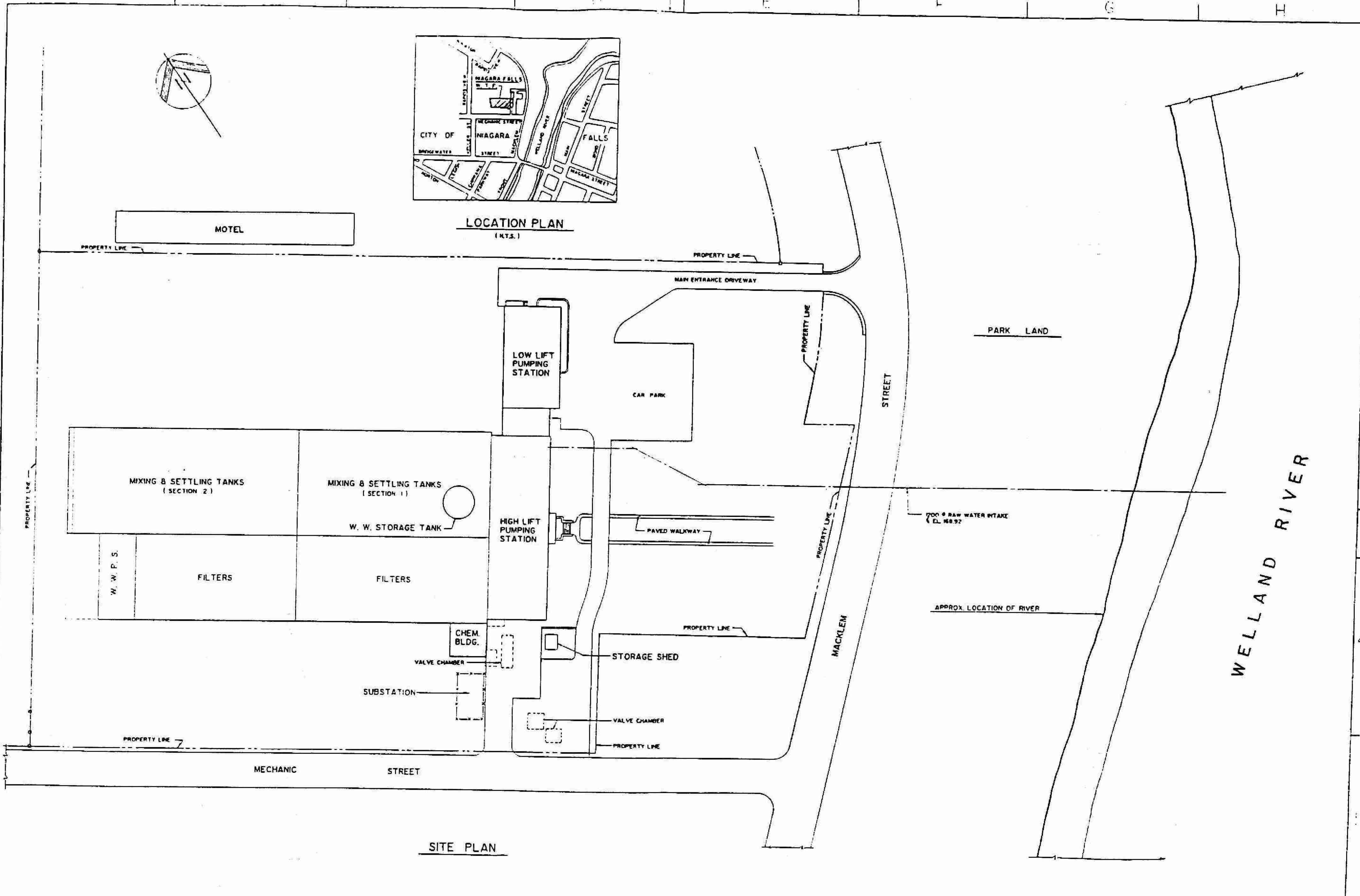
4- very poor

5- no floc

CONDUCTED BY Wendy Gray REVIEWED BY AWG.

APPENDIX E

DAILY LOG



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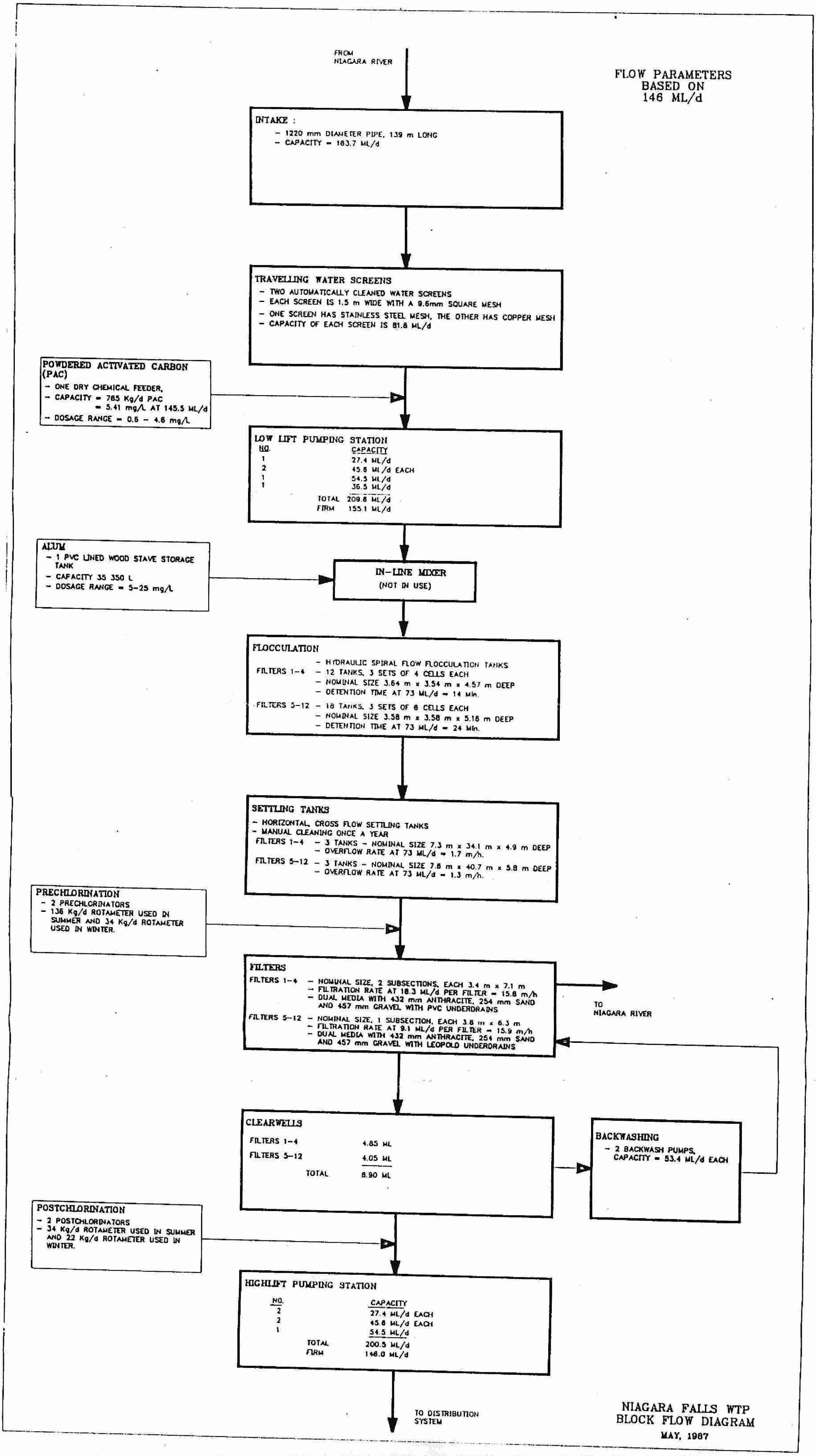
NOTES	CHECKED / DESIGNER / DEPARTMENT HEAD / PROJECT MANAGER	Gore & Storrie Limited	
NIAGARA FALLS WATER TREATMENT PLANT		Gore & Storrie Limited G&S — Consulting Engineers & Architect	
SITE & LOCATION PLAN		DATE MAY 1987	FILE Nº 38061-A1-REPORT
		SCALE 1:400	DRAWING Nº S1

SUPERSEDES ALL DRAWINGS BEARING PREVIOUS REVISION NUMBERS

APPENDIX F

DRAWINGS



FROM NIAGARA RIVER
FLOW PARAMETERS BASED ON 146 ML/d
INTAKE :
- 1220 mm DIAMETER PIPE, 139 m LONG
- CAPACITY = 183.7 ML/d
TRAVELLING WATER SCREENS
- TWO AUTOMATICALLY CLEANED WATER SCREENS
- EACH SCREEN IS 1.5 m WIDE WITH A 9.6mm SQUARE MESH
- ONE SCREEN HAS STAINLESS STEEL MESH, THE OTHER HAS COPPER MESH
- CAPACITY OF EACH SCREEN IS 81.8 ML/d
POWDERED ACTIVATED CARBON (PAC)
- ONE DRY CHEMICAL FEEDER.
- CAPACITY = 785 Kg/d PAC = 5.41 mg/L AT 145.5 ML/d
- DOSAGE RANGE = 0.6 - 4.6 mg/L
LOW LIFT PUMPING STATION
NO. CAPACITY
1 27.4 ML/d
2 45.8 ML/d EACH
1 54.5 ML/d
1 36.5 ML/d
TOTAL 209.8 ML/d
FIRM 155.1 ML/d
ALUM
- 1 PVC LINED WOOD STAVE STORAGE TANK
- CAPACITY 35 350 L
- DOSAGE RANGE = 5-25 mg/L
IN-LINE MIXER
(NOT IN USE)
FLOCCULATION
- HYDRAULIC SPIRAL FLOW FLOCCULATION TANKS
FILTERS 1-4 - 12 TANKS, 3 SETS OF 4 CELLS EACH
- NOMINAL SIZE 3.64 m x 3.54 m x 4.57 m DEEP
- DETENTION TIME AT 73 ML/d = 14 Min.
FILTERS 5-12 - 18 TANKS, 3 SETS OF 6 CELLS EACH
- NOMINAL SIZE 3.58 m x 3.58 m x 5.18 m DEEP
- DETENTION TIME AT 73 ML/d = 24 Min.
SETTLING TANKS
- HORIZONTAL, CROSS FLOW SETTLING TANKS
- MANUAL CLEANING ONCE A YEAR
FILTERS 1-4 - 3 TANKS - NOMINAL SIZE 7.3 m x 34.1 m x 4.9 m DEEP
- OVERFLOW RATE AT 73 ML/d = 1.7 m/h.
FILTERS 5-12 - 3 TANKS - NOMINAL SIZE 7.8 m x 40.7 m x 5.8 m DEEP
- OVERFLOW RATE AT 73 ML/d = 1.3 m/h.
PRECHLORINATION
- 2 PRECHLORINATORS
- 136 Kg/d ROTAMETER USED IN SUMMER AND 34 Kg/d ROTAMETER USED IN WINTER.
FILTERS
FILTERS 1-4 - NOMINAL SIZE, 2 SUBSECTIONS, EACH 3.4 m x 7.1 m
- FILTRATION RATE AT 18.3 ML/d PER FILTER = 15.8 m/h
- DUAL MEDIA WITH 432 mm ANTHRACITE, 254 mm SAND AND 457 mm GRAVEL WITH PVC UNDERDRAINS
FILTERS 5-12 - NOMINAL SIZE, 1 SUBSECTION, EACH 3.8 m x 6.3 m
- FILTRATION RATE AT 9.1 ML/d PER FILTER = 15.9 m/h
- DUAL MEDIA WITH 432 mm ANTHRACITE, 254 mm SAND AND 457 mm GRAVEL WITH LEOPOLD UNDERDRAINS
TO NIAGARA RIVER
CLEARWELLS
FILTERS 1-4 4.85 ML
FILTERS 5-12 4.05 ML
TOTAL 8.90 ML
BACKWASHING
- 2 BACKWASH PUMPS, CAPACITY = 53.4 ML/d EACH
POSTCHLORINATION
- 2 POSTCHLORINATORS
- 34 Kg/d ROTAMETER USED IN SUMMER AND 22 Kg/d ROTAMETER USED IN WINTER.
HIGHLIFT PUMPING STATION
NO. CAPACITY
2 27.4 ML/d EACH
2 45.8 ML/d EACH
1 54.5 ML/d
TOTAL 200.5 ML/d
FIRM 146.0 ML/d
TO DISTRIBUTION SYSTEM
NIAGARA FALLS WTP
BLOCK FLOW DIAGRAM
MAY, 1987

REGIONAL MUNICIPALITY OF NIAGARA

NIAGARA FALLS WATER SYSTEM

DAILY RECORD

DATE ______________ DAY OF WEEK ______________

TIME	SENIOR OPERATOR	OPERATOR

FILTER OPERATION

TIME	No. 1A		No. 1B		No. 2A		No. 2B		No. 3A		No. 3B		No. 4A		No. 4B		No. 5A		No. 6		No. 7		No. 8		No. 9		No. 10		No. 11		No. 12	
	HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.	
	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP
0000																																
0300																																
0600																																
0900																																
1200																																
1500																																
1800																																
2100																																
2400																																
	HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.		HRS.	

ALARMS

DESCRIPTION	TIME REC'D.	TIME CLEARED

WATER TESTS

TIME	RAW	SETTLED		EFFLUENT OF LONGEST RUNNING FILTER						FINISHED, POST-CHLORINATED				
				SECTION NO. 1			SECTION NO. 2				CHLORINE RESIDUAL mg/L			
	TURBIDITY N.T.U.	TURBIDITY N.T.U. SECT. 1	SECT. 2	FILTER NO.	TURBIDITY N.T.U.	Cl_2 RESID. FREE mg/L	FILTER NO.	TURBIDITY N.T.U.	Cl_2 RESID. FREE mg/L	TURBIDITY N.T.U.	FREE	COMB.	TOTAL	% F/T
0200														
0600														
1000														
1400														
1800														
2200														

FILTER BACKWASH

FILTER No.	HOURS RUN	HEAD LOSS METRES	EFFLUENT TURBIDITY N.T.U.	BACK WASH TIME	USED TANK	USED PUMP No.	WASH min.

RAW WATER SCREENS CLEANED

TIME

REMARKS:

____

____

____

____

____

____

____

CHEMICALS

TIME	LIQUID ALUM				CHLORINE				
	TANK	USED	DOSAGE mg/L		SCALE		DOSAGE mg/L		
	LITRES	LITRES	ACTUAL	SET	WEIGHT kg	USED kg	ACTUAL TOTAL	SET PRE	SET POST
0000									
0800									
1600									
2400									
TOTAL					TOTAL				

PUMPS - ELAPSED TIME RUNNING - HOURS

TIME	TREATMENT PLANT												KENT AVENUE PUMPING STATION			
	LOW LIFT PUMPS					HIGH LIFT PUMPS					WASH WATER PUMPS		HIGH LIFT PUMPS			
	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 1	NO. 2	NO. 11	NO. 12	NO. 13	NO. 14
2400																
0000																
THIS DAY																

WATER LEVELS

TIME	PLANT			DISTRIBUTION SYSTEM				
	LOW LIFT WELL METRES		CLEAR WELL	LEVEL	LUNDY'S LANE ELEVATED TANK		KENT AVENUE RESERVOIR	
	1	2	METRES		%	TIME	%	TIME
0200				MIDNIGHT		2400		2400
0600				HIGHEST				
1000				LOWEST				
1400				NOON READINGS	RAW WATER TEMP. C		HYDRO PEAK	
1800								
2200								

PUMP AND VALVE OPERATION

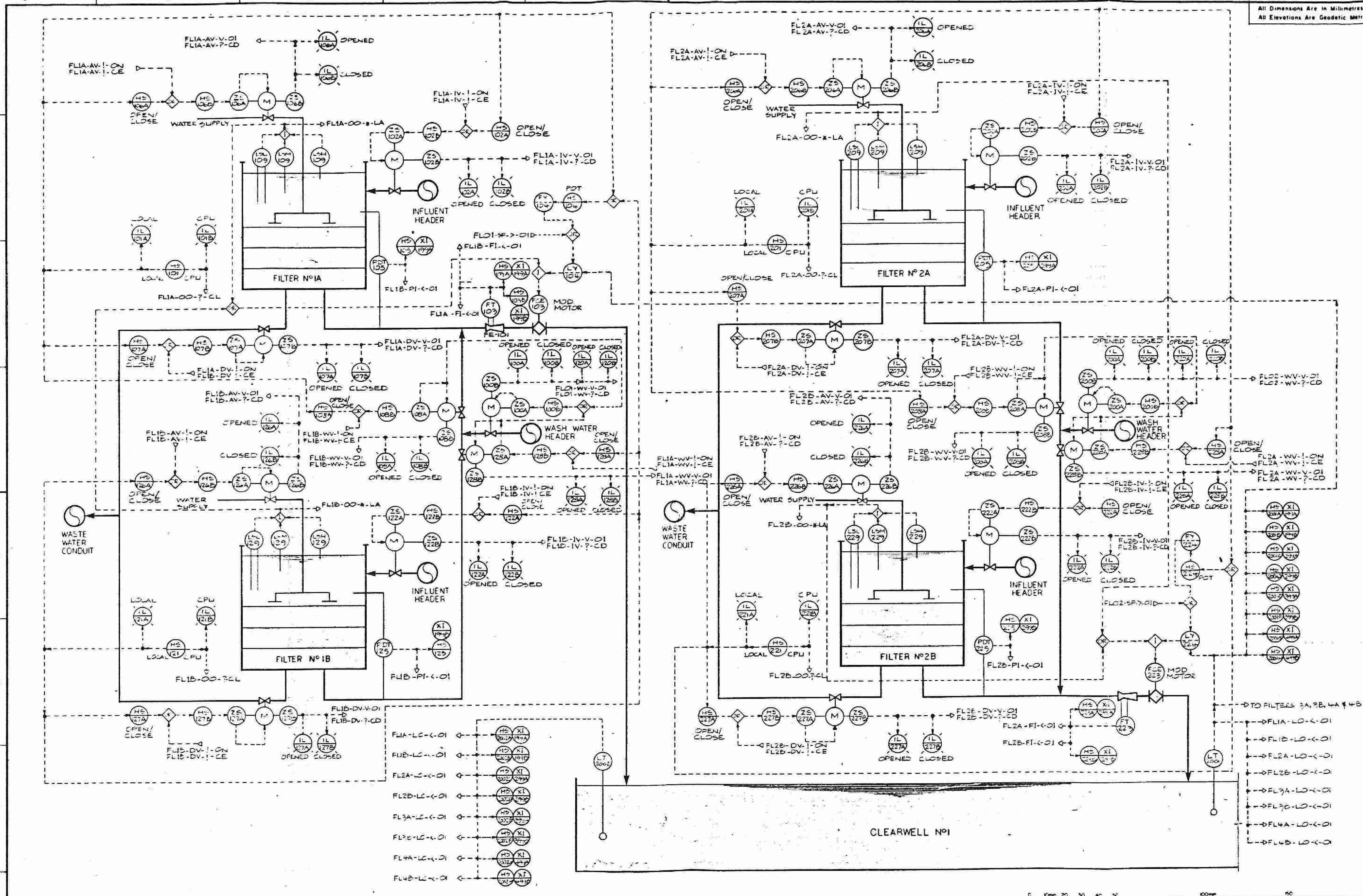
TIME	LOW LIFT PUMPS										HIGH LIFT PUMPS										KENT AVENUE RESERVOIR AND PUMPING STATION											
																					FILL VALVES				HIGH LIFT PUMPS							
	NO. 1		NO. 2		NO. 3		NO. 4		NO. 5		NO. 1		NO. 2		NO. 3		NO. 4		NO. 5		300 mm		400 mm		NO. 11		NO. 12		NO. 13		NO. 14	
	27 ML/d		45 ML/d		55 ML/d		36 ML/d		45 ML/d		45 ML/d		45 ML/d		27 ML/d		27 ML/d		55 ML/d						23 ML/d		45 ML/d				23 ML/d	
	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP	START	STOP
0000																																
0300																																
0600																																
0900																																
1200																																
1500																																
1800																																
2100																																
2400																																
																					TOTAL TIME OPEN THIS DAY: HRS		HRS									

FLOW METERS

TIME	PLANT				TIME	KENT AVENUE	
	RAW WATER		FINISHED WATER			READINGS	
	READING	m^3	READING	m^3		GALLONS x 1000	
						STATION DISCHARGE	RESERVOIR INFLUENT
0000		x 10		x 10	2400		
0800					0000		
1600					THIS DAY		
2400							
	TOTAL		TOTAL		(+ or −)		

DATE ______________

All Dimensions Are in Millimetres
All Elevations Are Geodetic Metric



NO	REVISION	DATE	INIT

NOTES

DRAWN BY AM
DESIGNED BY TC
CHECKED BY TC/A.U.B.

A.U. BOWERS

Simcoe

Simcoe Engineering Group Limited
Consulting Engineers

Regional NIAGARA
PUBLIC WORKS DEPARTMENT
The Regional Municipality of Niagara

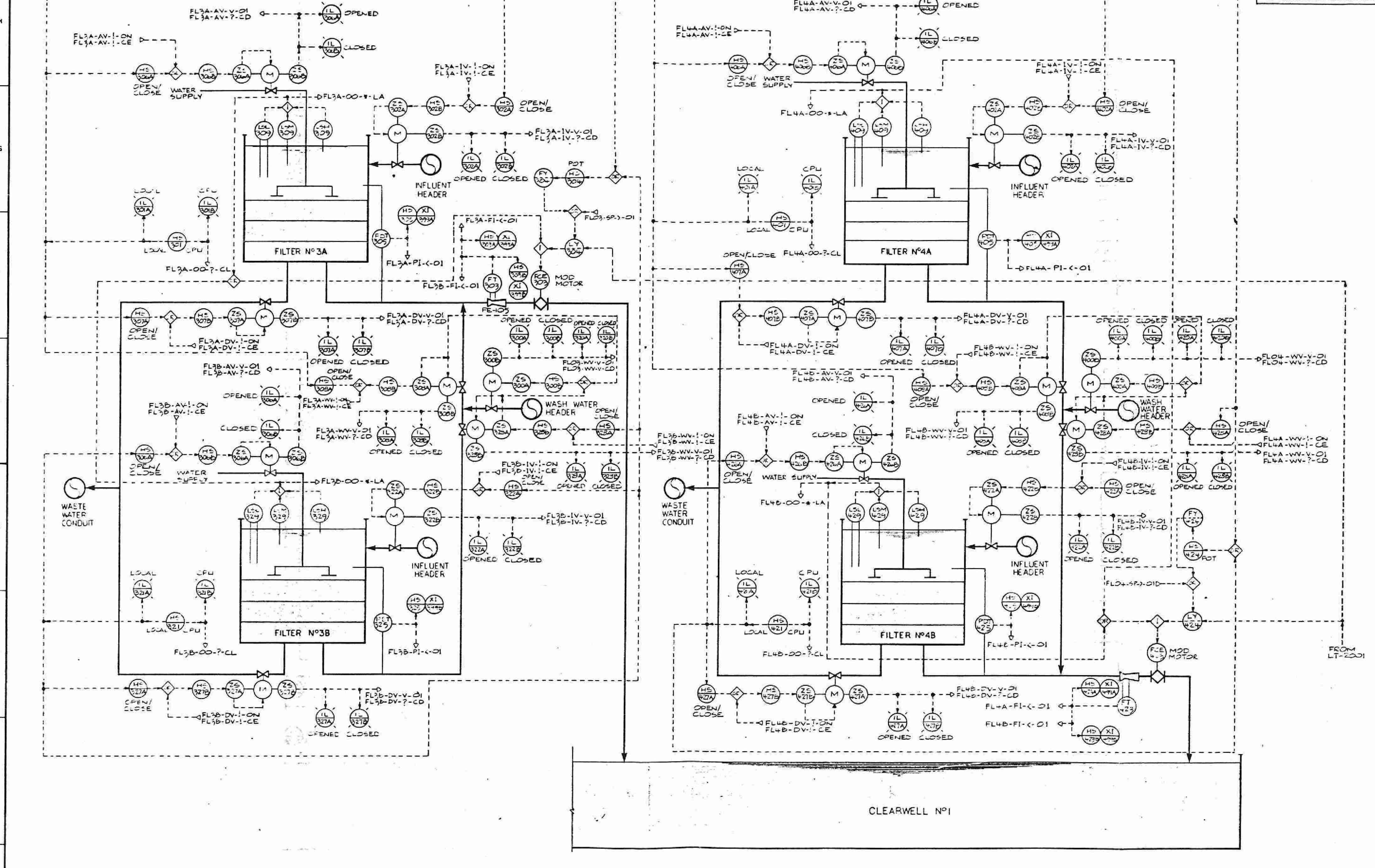
NIAGARA FALLS WATER TREATMENT PLANT
FILTER UPGRADING RN-84-29

TITLE
FILTERS PROCESS AND INSTRUMENTATION DIAGRAM (1)

FIELD NOTES
DATE SEPTEMBER 1984
SCALE
DWG No E1
MUN REF No
REV

11201-A1-1193

All Dimensions Are In Millimetres
All Elevations Are Geodetic Metric



NO	REVISION	DATE	INIT

NOTES

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DESIGNED BY TC
CHECKED BY TC/A...

REGISTERED PROFESSIONAL ENGINEER — A. A. BOWERS — PROVINCE OF ONTARIO

Simcoe

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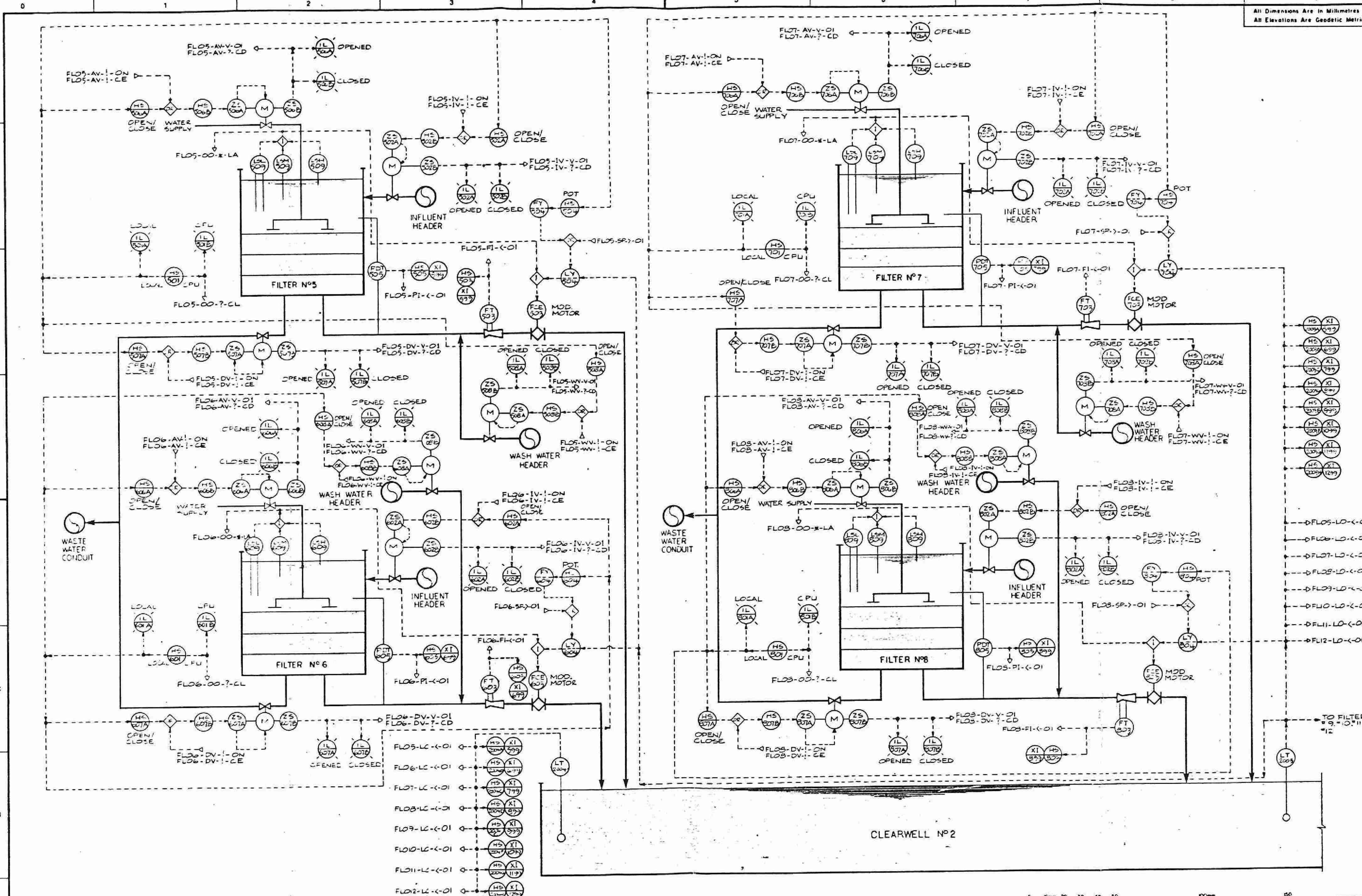
Regional NIAGARA
PUBLIC WORKS DEPARTMENT
The Regional Municipality of Niagara

NIAGARA FALLS WATER TREATMENT PLANT
FILTER UPGRADING RN-84-29

TITLE
FILTERS PROCESS AND INSTRUMENTATION DIAGRAM (2)

FIELD NOTES
DATE SEPTEMBER 1984
SCALE
DWG No E2
MUN REF No
REV

1120I-AI-1194



NOTES

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A. J. BOWERS
PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO

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PUBLIC WORKS DEPARTMENT
The Regional Municipality of Niagara

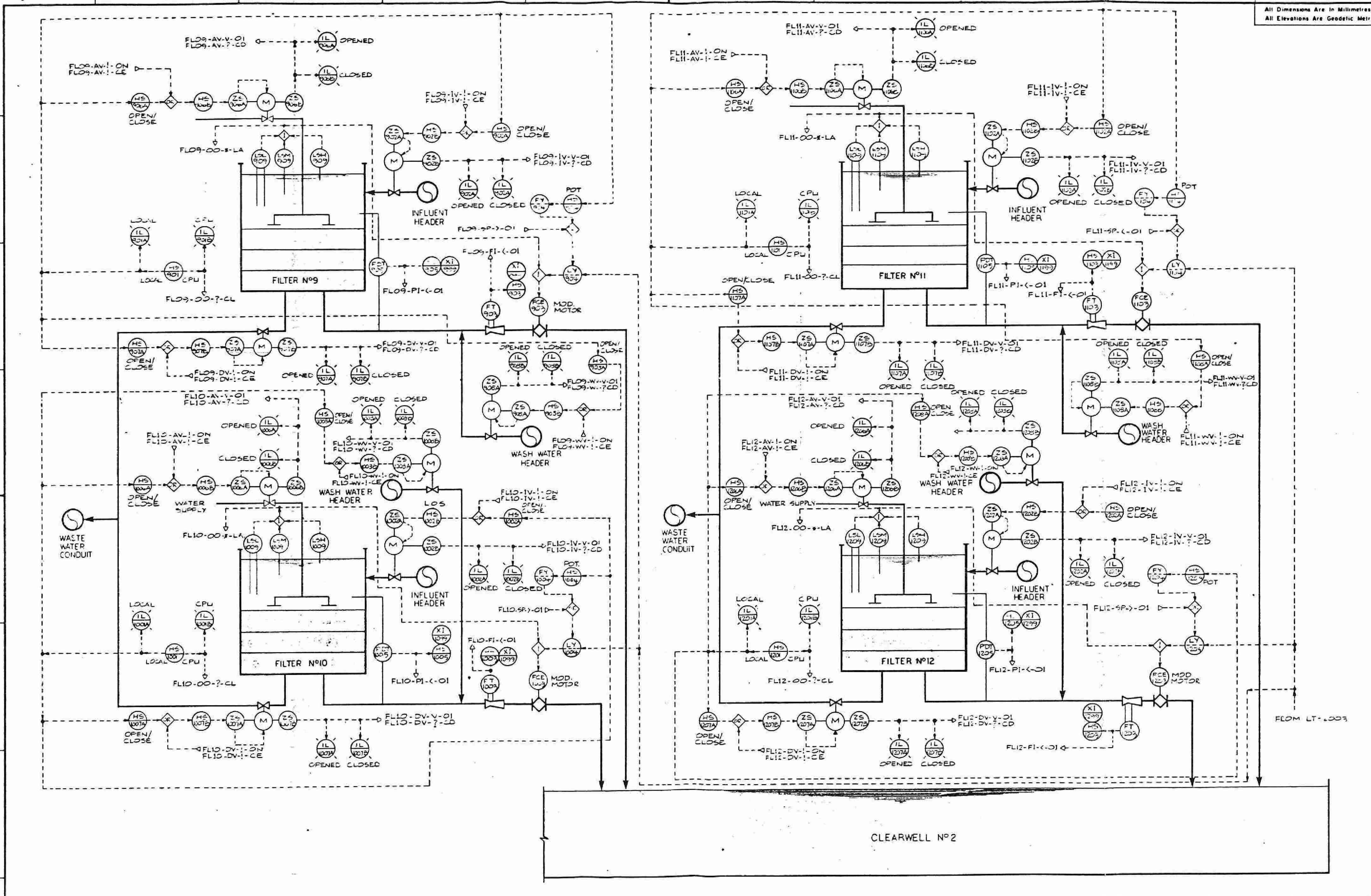
NIAGARA FALLS WATER TREATMENT PLANT
FILTER UPGRADING RN-84-29

TITLE
FILTERS PROCESS AND INSTRUMENTATION DIAGRAM (3)

FIELD NOTES
DATE SEPTEMBER 1984
SCALE
DWG No E3
MUN REF No
REV

NO	REVISION	DATE	INIT

1120I-AI-1195



NO	REVISION	DATE	INIT

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DESIGNED BY TC

CHECKED BY TC/

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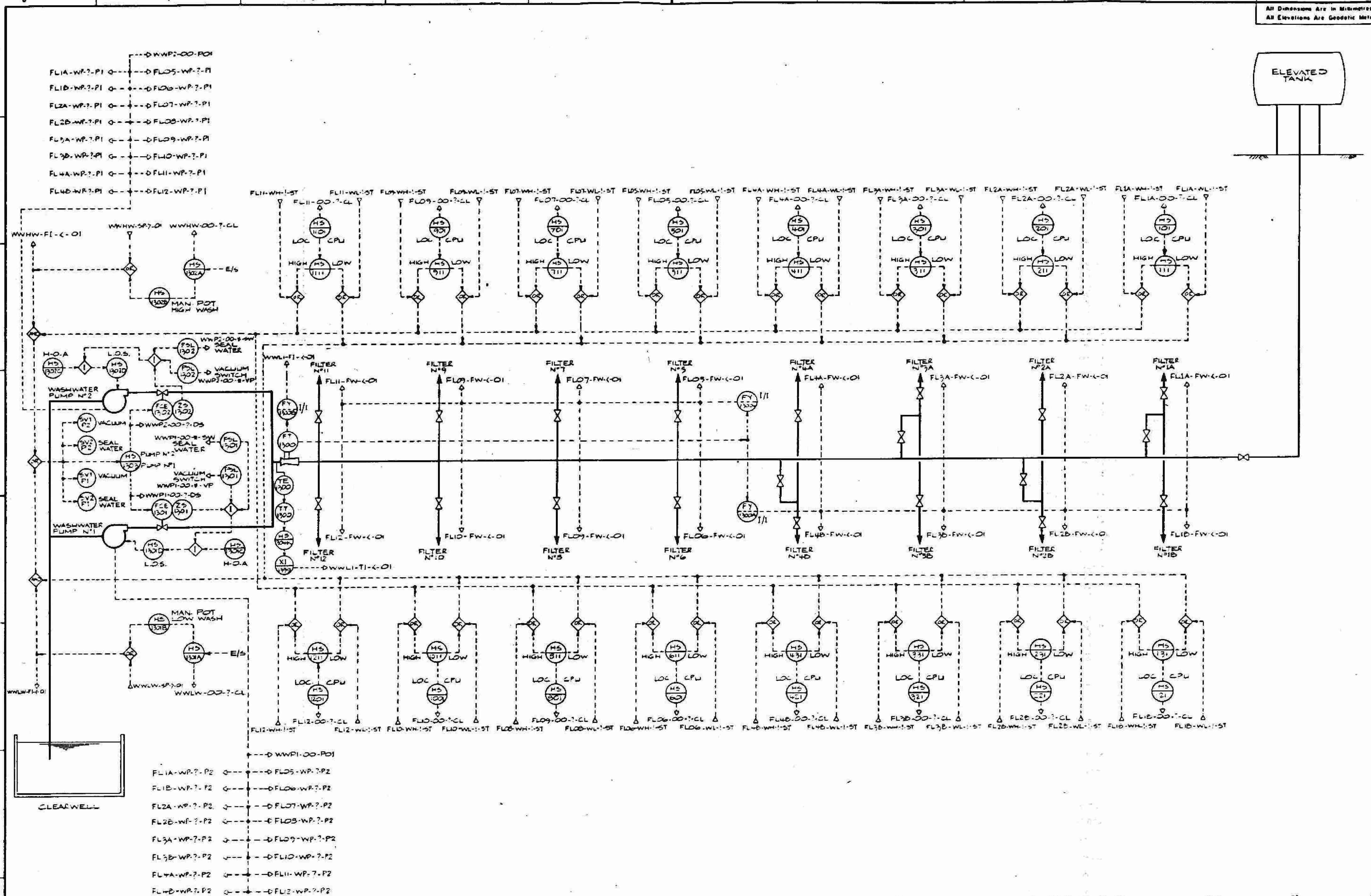
PUBLIC WORKS DEPARTMENT
The Regional Municipality of Niagara

NIAGARA FALLS WATER TREATMENT PLANT
FILTER UPGRADING RN-84-29

TITLE
FILTERS PROCESS AND INSTRUMENTATION DIAGRAM (4)

FIELD NOTES
DATE SEPTEMBER 1984
SCALE
DWG No E4
MUN REF No
REV

All Dimensions Are In Millimetres
All Elevations Are Geodetic Metric



NO	REVISION	DATE	

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A. J. EDWARDS

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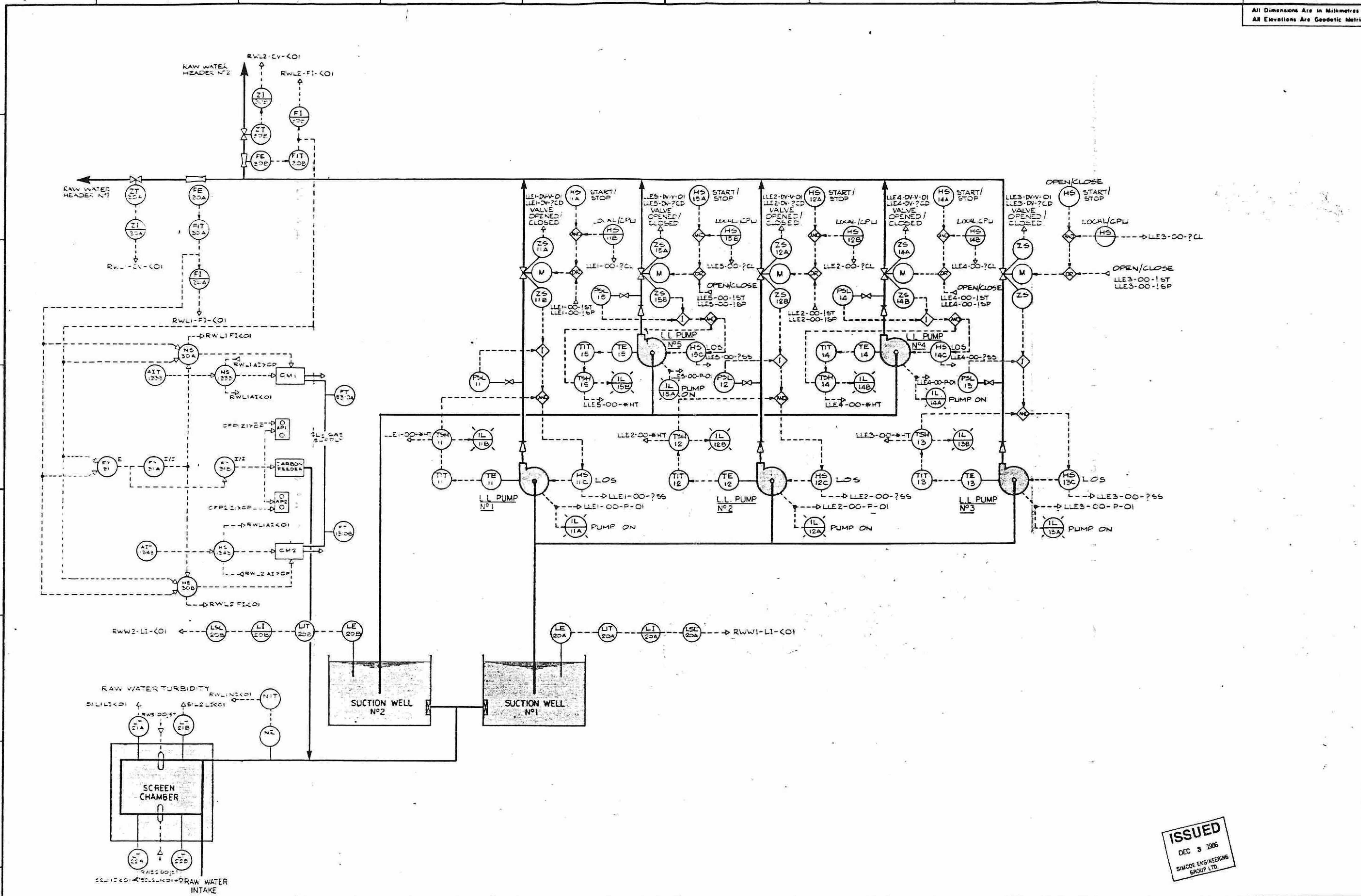
The Regional Municipality of Niagara

NIAGARA FALLS WATER TREATMENT PLANT
FILTER UPGRADING RN-84-29

TITLE
WASHWATER
PROCESS AND INSTRUMENTATION
DIAGRAM

DATE SEPTEMBER 1984
SCALE
DWG No E5



NO	REVISION	DATE	INIT

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PUBLIC WORKS DEPARTMENT
The Regional Municipality of Niagara

NIAGARA FALLS WATER TREATMENT PLANT
COMPUTER SYSTEM RN-85-1

TITLE

LOW LIFT
PROCESS & INSTRUMENTATION DIAGRAM

FIELD NOTES

DATE APRIL, 1985

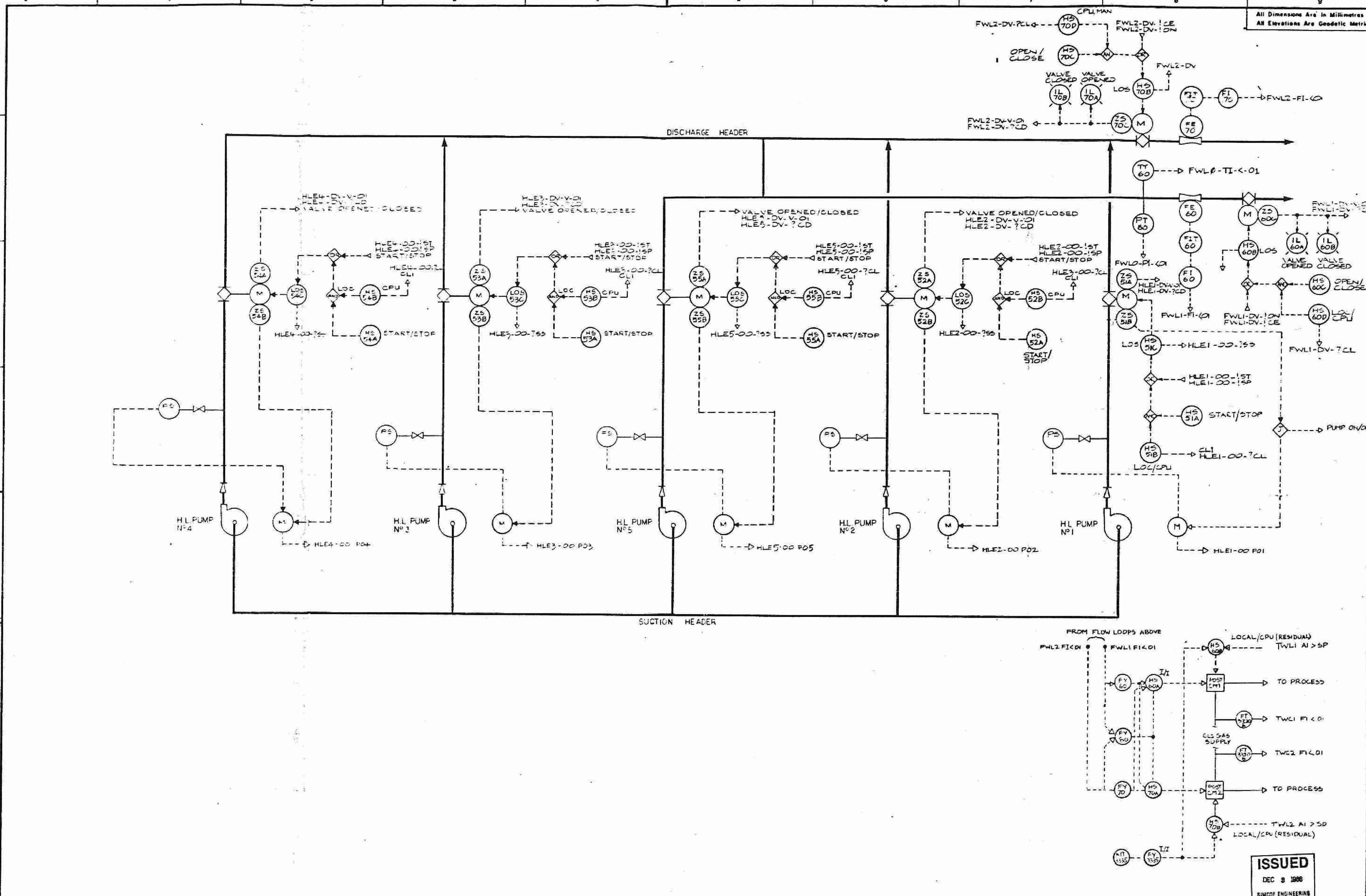
SCALE

DWG No CS-6

MUN REF No

REV

112-02-A1-1044



NO	REVISION	DATE	INIT

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PUBLIC WORKS DEPARTMENT
The Regional Municipality of Niagara

NIAGARA FALLS WATER TREATMENT PLANT
COMPUTER SYSTEM RN-85-1

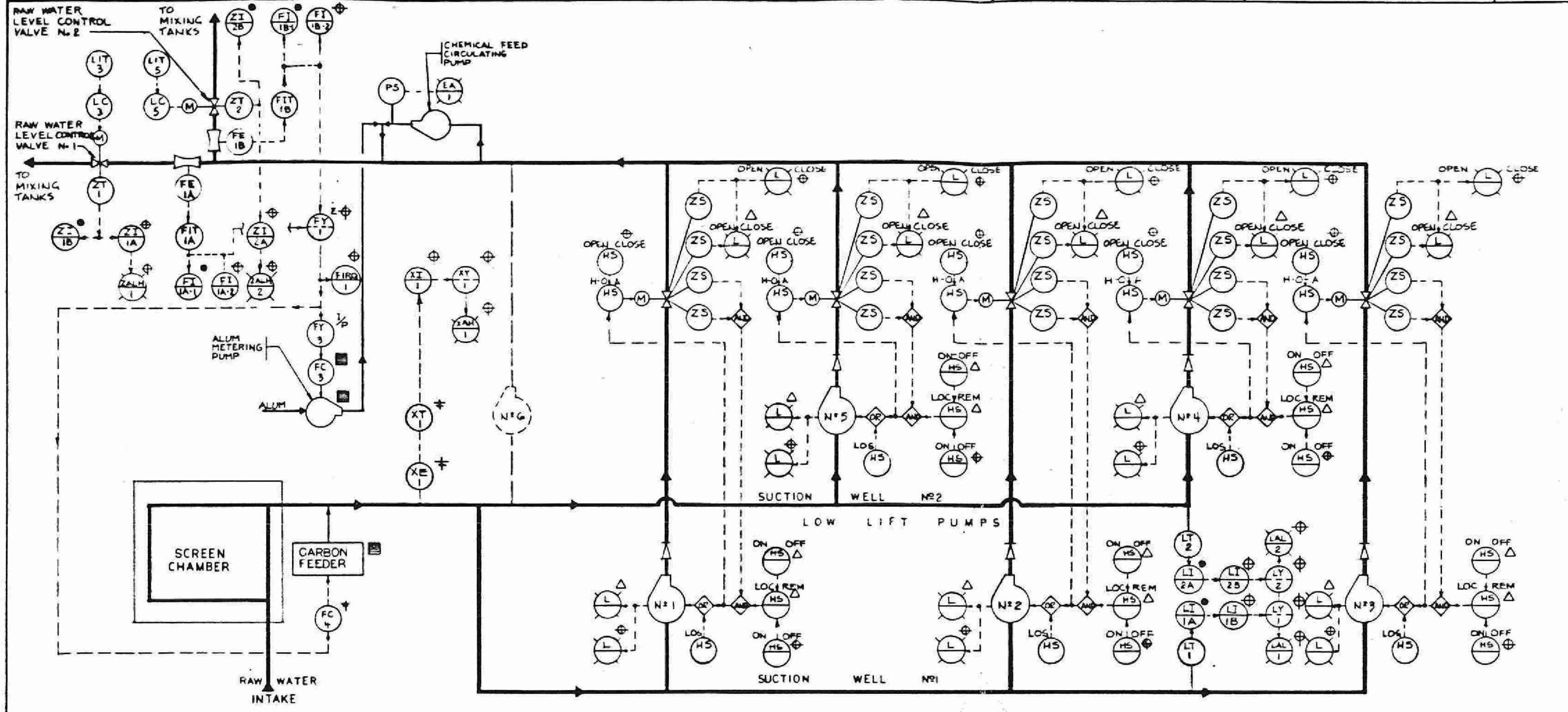
TITLE

HIGH LIFT

PROCESS & INSTRUMENTATION DIAGRAM

FIELD NOTES
DATE APRIL, 1985
SCALE
DWG No CS-7
MUN REF No
REV

112 02-A1-1645



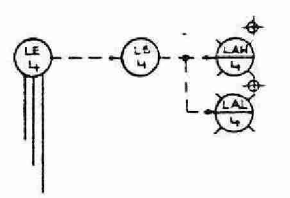
RAW WATER PROCESS AND INSTRUMENTATION DIAGRAM

LEGEND FOR THIS DRAWING

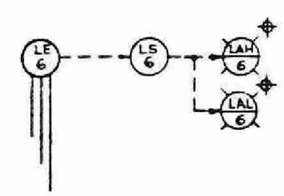
- FRONT OF PANEL MOUNTED
- BACK OF PANEL MOUNTED
- FIELD MOUNTED
- EXISTING EQUIPMENT
- △ LOCATED IN MCC OR POWER PANEL BOARD
- --- ELECTRICAL SIGNAL
- —— CONNECTED TO PROCESS OR MECHANICAL LINK
- ⊕ LOCATED IN MAIN CONTROL PANEL
- ● IN RAW WATER FLOW PANEL
- ▲ IN FINISHED WATER FLOW PANEL

TAG No

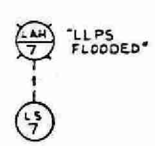
	FIRST LETTER	SUCCEEDING LETTER
A	ANALYSER	ALARM
C	CHLORINE	CONTROLLER
D		DIFFERENTIAL
E		ELEMENT
F	FLOW RATE	
H	HAND (MANUALLY INITIATED)	HIGH
I		INDICATOR
K	TIME OR SCHEDULE	
L	LEVEL OR LIGHT	LOW
P	PRESSURE	
Q		TOTALIZER
R		RECORDER
S	SPEED	SWITCH
T		TRANSMITTER
U	MULTIVARIABLE	
Z	POSITION	
X	TURBIDITY	
Y		RELAY OR COMPUTE
J	POWER	
✝	SUPPLIED AND INSTALLED UNDER ANOTHER DIVISION, BUT CONNECTED UNDER DIVISION 16	



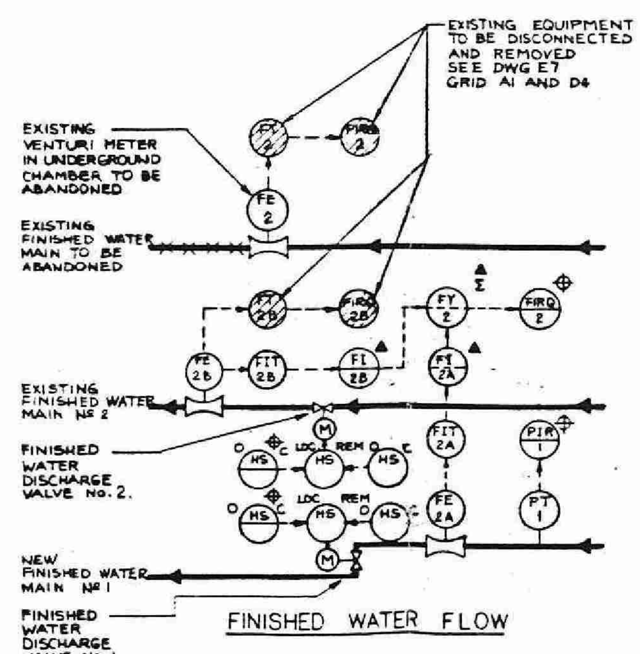
SECTION I
SETTLED WATER CONDUIT
LEVEL ALARM



SECTION II
SETTLED WATER CONDUIT
LEVEL ALARM



LLPS
FLOOD ALARM



FINISHED WATER FLOW

No	REVISION	DATE	INIT

GORE & STORRIE LIMITED
CONSULTING ENGINEERS
TORONTO / ST. CATHARINES

GORE AND STORRIE LIMITED

V.P.

Niagara Region
Public Works and Utilities Department

NIAGARA FALLS WATER TREATMENT PLANT
UPGRADING OF LOW & HIGH LIFT STATIONS
CONTRACT RN 82-13

PROCESS & INSTRUMENTATION DIAGRAMS

SCALE	N.T.S.
DATE	MAY 1982
FILE No	452.47-A1-02319
DWG. No	E 8

TERMS OF REFERENCE

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE

Purpose

To review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

Work Tasks

1. Receive a package of available information on the plant from the MOE. Review the information provided and meet with the MOE staff to discuss the project.

2. Document the quality and quantity of raw and treated waters. Along with Work Task 3, send a progress report to the Project Committee at the conclusion of this work.

3. Define the present treatment processes and operating procedures. Along with Work Task 2, send a progress report to the Project Committee at the conclusion of this work.

4. Assess methods of efficient particulate removal which would utilize the present major capital works of the plant. Evaluate the particulate removal efficiency and sensitivity of operation, assuming optimum performance of the plant. Along with Work Task 5, send a progress report to the Project Committee at the conclusion of this work.

5. Assess methods which would improve, if necessary, the disinfection practices of the plant, keeping in mind a desire to minimize the production of chlorinated by-products in the treated water. Along with Work Task 4, send a progress report to the Project Committee at the conclusion of this work.

6. Describe possible short and long-term process modifications to obtain optimum disinfection and contaminant removal, with emphasis on particulate removal and a desire to minimize the production of chlorinated by-products. Meet with the Project Committee at the conclusion of this work to review the report information.

7. Prepare 7 copies of the draft report and submit to the Project Committee.

8. Review the Project Committee's comments and prepare 25 copies of the final report.

11/08/86

1. RECEIVE A PACKAGE OF AVAILABLE INFORMATION ON THE PLANT FROM THE MOE. REVIEW THE INFORMATION PROVIDED AND MEET WITH THE MOE STAFF TO DISCUSS THE PROJECT.

Elements of Work

(a) Receive a package of available information from the MOE concerning the plant.

(b) Review the information and otherwise prepare for a meeting to initiate work on the project, including preparation of a schedule of manpower and staff requirements.

(c) Meet with the MOE to discuss the available data, the terms of reference, and the project staff and work schedule.

2. DOCUMENT THE QUALITY AND QUANTITY OF RAW AND TREATED WATERS. ALONG WITH WORK TASK 3, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Tabulate the daily raw and treated water flows for the last three consecutive years.

(b) Document the methods of measuring the raw and treated water flow rates, and assess the validity of the records.

(c) Prepare a monthly summary of maximum, minimum, and average flows for the three years. Address any discrepancies which exist between raw and treated flow rates.

(d) Review and assess the monthly maximum, minimum, and average per capita flow for the three years. Compare the plant data with typical per capita flows for the local region.

(e) Document a summary, based on at least three years of data, of the raw and treated water quality testing data for physical, microbiological, radiological, and chemical water quality information. Document as much data as is needed to show possible seasonal trends in water quality. Where possible, show corresponding sets of raw and treated water quality information. Document the source and methods used in determining all water quality information. Assess the validity of the data, comparing plant and outside laboratory data.

(f) Tabulate, for the last three consecutive years, where available, raw and treated water turbidity, residual aluminum, pH, and colour. Record other data, such as particle counting, suspended solids, and algae counting, which could reflect on particulate removal efficiency. These data should be used for assessment of the particulate removal efficiency of the plant. Document the source and methods used in determining all information. A comparison should be made between the plant and outside laboratory information to ascertain the relative validity of the data. For plant data, emphasis should be given to plant laboratory tests rather than continuous process control instruments.

(g) Tabulate, for the last three consecutive years, the raw water bacterial test information at the plant. Also tabulate the corresponding treated water tests at the plant which register positive results. Document the source and methods used for all data provided. This information should be used to assess the effectiveness of the disinfection practices at the plant.

(h) Identify and recommend other water quality concerns, not related to particulate removal or disinfection, which should be considered as part of the assessment phase of this evaluation program.

(i) Submit a progress report to the Project Committee.

3. DEFINE THE PRESENT TREATMENT PROCESSES AND OPERATING PROCEDURES. ALONG WITH WORK TASK 2, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSIONS OF THIS WORK.

Elements of Work

(a) Where drawings are available, assemble sufficient record drawings, of a reduced size, to document the general site layout and the interrelationship of major plant components. If not already available, prepare a process and piping diagram (PAPD) of the plant operations.

(b) Prepare a simplified block schematic of the major plant components.

(c) Prepare a photographic record of the plant facilities, illustrating all of the major plant components and chemical feed systems.

(d) Tabulate the design parameters for all of the major plant components, with emphasis on the process operations, including chemical feeds. This information, as a minimum, must be consistent with the DWSP Questionnaire and must be confirmed and verified by field observations.

(e) Prepare a brief summary of how the plant is operated, including chemical dosage control, such as jar testing information, filter backwashing procedures and initiation, and pumping and flow control.

(f) Document and assess any reported problems in plant operations and/or in the distribution system related to water quality.

(g) Tabulate the daily average chemical dosages for the last three consecutive years. Document the methods used to evaluate chemical dosages and establish the validity of the dosage information provided.

With regard to disinfection, tabulate the dosages of chlorine and disinfection-related chemicals such as chlorine dioxide. In addition, provide corresponding data on disinfectant residuals in the plant, such as free and total chlorine residuals. Also, provide chlorine demand tests where available. Again, document the methods of dosage evaluation and residual measurements, and establish the validity of the data provided.

(h) Submit a progress report to the Project Committee.

4. ASSESS METHODS OF EFFICIENT PARTICULATE REMOVAL WHICH WOULD UTILIZE THE PRESENT MAJOR CAPITAL WORKS OF THE PLANT. EVALUATE THE PARTICULATE REMOVAL EFFICIENCY AND SENSITIVITY OF OPERATION, ASSUMING OPTIMUM PERFORMANCE OF THE PLANT. ALONG WITH WORK TASK 5, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using information provided in Work Tasks 1 and 2, evaluate the plant's particulate removal efficiency. The basis of minimum particulate removal should be 1.0 FTU, which is the maximum acceptable concentration of the Ontario Drinking Water Objectives (Table 1, page 2, Ontario Ministry of the Environment, Revised 1983). It should, however, be recognized that it is desirable to strive for an operational level which is as low a turbidity level as is achievable.

(b) Conduct an evaluation of possible optimum performance alternatives, including jar testing of plant water samples.

(c) Evaluate the feasibility of optimum removals using the existing plant capital works. This evaluation should consider the worst case water quality conditions, even though field testing data may not be available during the initial phase of the study (see Work Task 7).

(d) Describe the operational procedures, management strategies, and equipment required for various feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation of the alternatives.

(e) Report to the Project Committee.

5. ASSESS METHODS WHICH WOULD IMPROVE, IF NECESSARY, THE DISINFECTION PRACTICES OF THE PLANT, KEEPING IN MIND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS IN THE TREATED WATER. ALONG WITH WORK TASK 4, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using the information provided in Work Tasks 1 and 2, evaluate the plant's ability to disinfect the water. The basis of minimum disinfection should be to ensure a water quality as described in the Ontario Drinking Water Objectives (Ontario Ministry of the Environment, Revised 1983).

(b) Conduct an evaluation of possible optimum disinfection procedures for the plant, with consideration also given to the reduction of chlorinated by-products in the treated water.

(c) Evaluate the feasibility of the various alternatives using the existing plant capital works. Estimate the initial and final levels of chlorinated by-products for the various alternatives. Assess the relative merits of the alternatives.

(d) Describe the operational procedures, management strategies, and equipment required for the feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation for the alternatives.

(e) Report to the Project Committee.

6. DESCRIBE POSSIBLE SHORT AND LONG-TERM PROCESS MODIFICATIONS TO OBTAIN OPTIMUM DISINFECTION AND CONTAMINANT REMOVAL, WITH EMPHASIS ON PARTICULATE REMOVAL AND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS. MEET WITH THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK TO REVIEW THE REPORT INFORMATION.

Elements of Work

(a) It is not the purpose of this study to provide a detailed implementation scheme for plant rehabilitation. It is, however, necessary to scope the feasible short and long-term process modifications required to achieve optimum disinfection and contaminant removals.

Prepare a list of modifications which should be considered for detailed implementation evaluation. Provide an estimated cost for each of the proposed modifications.

(b) Prepare a schedule for the list of modifications.

(c) Meet with the Project Committee at the plant site to review the proposed modifications.

7. PREPARE 7 COPIES OF THE DRAFT REPORT AND SUBMIT TO THE PROJECT COMMITTEE.

Elements of Work

(a) The report must include all the information reported previously in the study. The information must be organized and presented in a logical and co-ordinated fashion.

A general table of contents will be provided for organizing the material in a manner consistent with other plant reports.

(b) Submit the draft report to the Project Committee for review.

(c) Prepare a separate letter report containing a recommendation(s) concerning the need for additional field testing to cover water quality conditions not available during the period of this study. The Project Committee may decide to delay completion of the final report until field data can be obtained to confirm the predictions of performance for the worst case water conditions.

8. REVIEW THE PROJECT COMMITTEE'S COMMENTS AND PREPARE 25 COPIES OF THE FINAL REPORT.

Elements of Work

(a) Conduct additional field testing if required. Discuss the implications of the results with the Project Committee if the results differ from the predicted performance.

(b) Amend the report as per review comments, incorporating additional field data if required.

(c) Submit copies of the final reports to the MOE for distribution.